Introduction

The National Institute of Standards and Technology (NIST) facilitated the development of this Footwear and Tire Examination Process Map through a collaboration between the NIST Forensic Science Research Program and the NIST administered Organization of Scientific Area Committees (OSAC) for Forensic Sciences (specifically OSAC's Footwear and Tire Subcommittee).

This Footwear and Tire Examination Process Map (Current Practice) captures details about the various procedures, methods and decision points most frequently encountered in the discipline of footwear and tire examination from a national perspective and **is intended to reflect current practices**. The discipline requires examiners to make many decisions that can impact the quality and accuracy of results. The Footwear and Tire Examination Process Map can benefit the discipline by providing a behind-the-scenes perspective into the various components and decision points in the examination process.

Process mapping is the visual representation of the critical steps and decision points of a process. Components of the process are deconstructed, placed into specific shapes within a flowchart and connected by one-way arrows to indicate directionality regarding decisions as well as progression throughout the overall process. The shape of each box assists the reader by representing a specific type of activity.

This process map captures the **diverse** practices of multiple laboratories, with the goal of allowing a footwear and tire examiner to find their process represented in the map. To ensure this, the mapping team avoided creating a map of what **should** be done (i.e. best practices) and instead attempted to represent all reasonable variations of casework **currently performed** by footwear and tire examiners. For this reason, it is important to state that the OSAC Footwear and Tire Subcommittee does not necessarily support or endorse (as best practices) all of the different steps and paths depicted in this process map.

This map is not intended to be a step-by-step instruction manual outlining minutia, nor is it intended to be so broad that it lacks utility. Rather, judgements were made by the process mapping group as to which steps should be combined and which steps should be divided further. Certain processes represented in the map have a required sequence while other components may vary by examiner or agency. Processes and decisions may also be dictated by agency policy or law.

Process Map Applications:

The Footwear and Tire Examinaton Process Map is intended to be used to help improve efficiencies while reducing errors, highlight gaps where further research or standardization would be beneficial, and assist with training new examiners. It may also be used to develop specific laboratory policies and identify best practices.

Scope of the Footwear and Tire Examaintion Process Map:

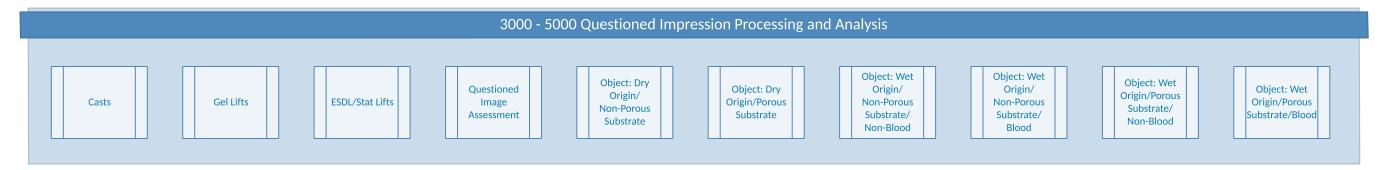
The scope of Footwear and Tire Examination Process Map is limited to core processes within the discipline of footwear and tire examination such as the examination of questioned footwear and tire impressions and the comparison of these impressions to known footwear or tires. Several topics are omitted from this map including crime scene collection and intercomparison of questioned impressions. These topics may subsequently be addressed by the process mapping team, an individual laboratory or a standardization committee.



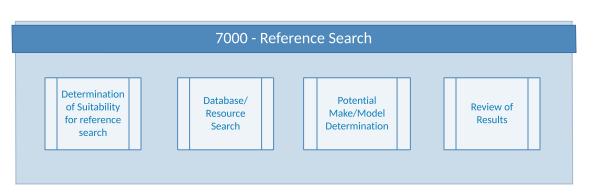


















<u>Underlined Word</u> Word that will be defined in the glossary Technology Assist

Technology that aids in the steps on this page

Input Box
Outlines the inputs at
the beginning of each section

Output Box
Describes an
output of the
steps on the
page

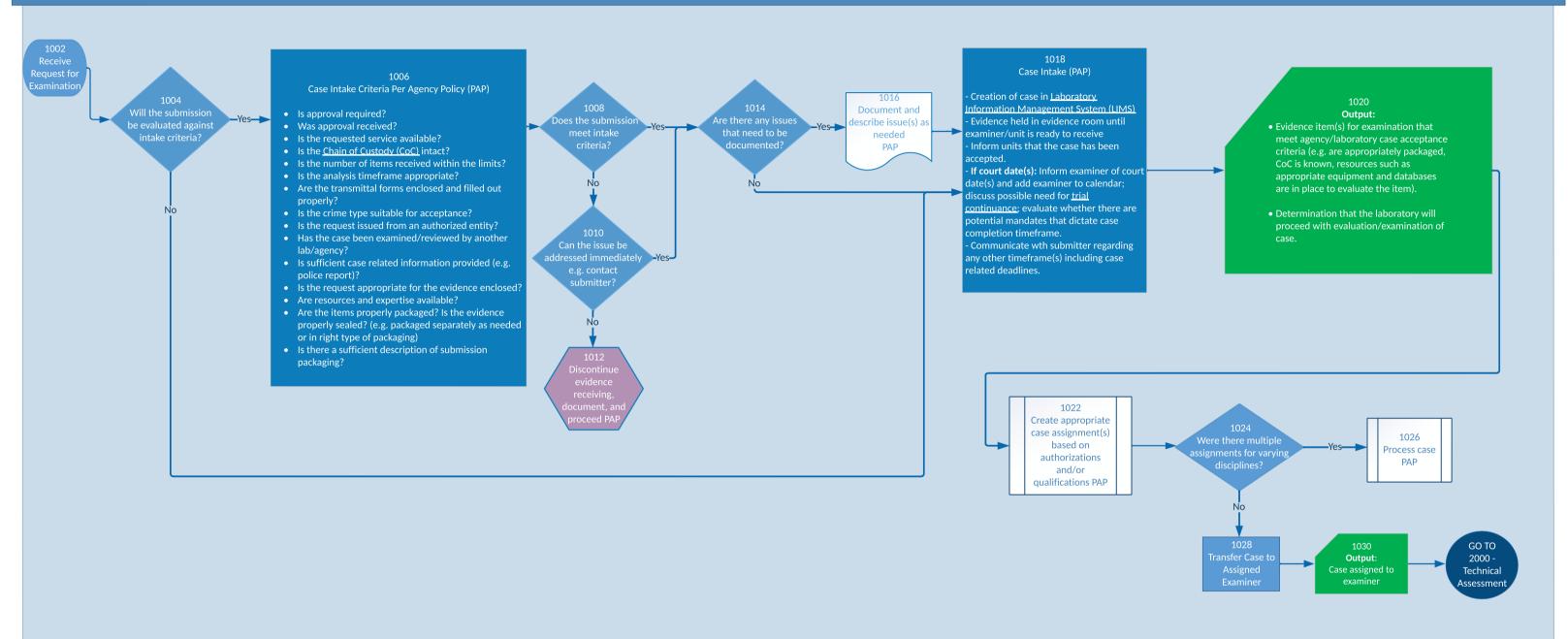






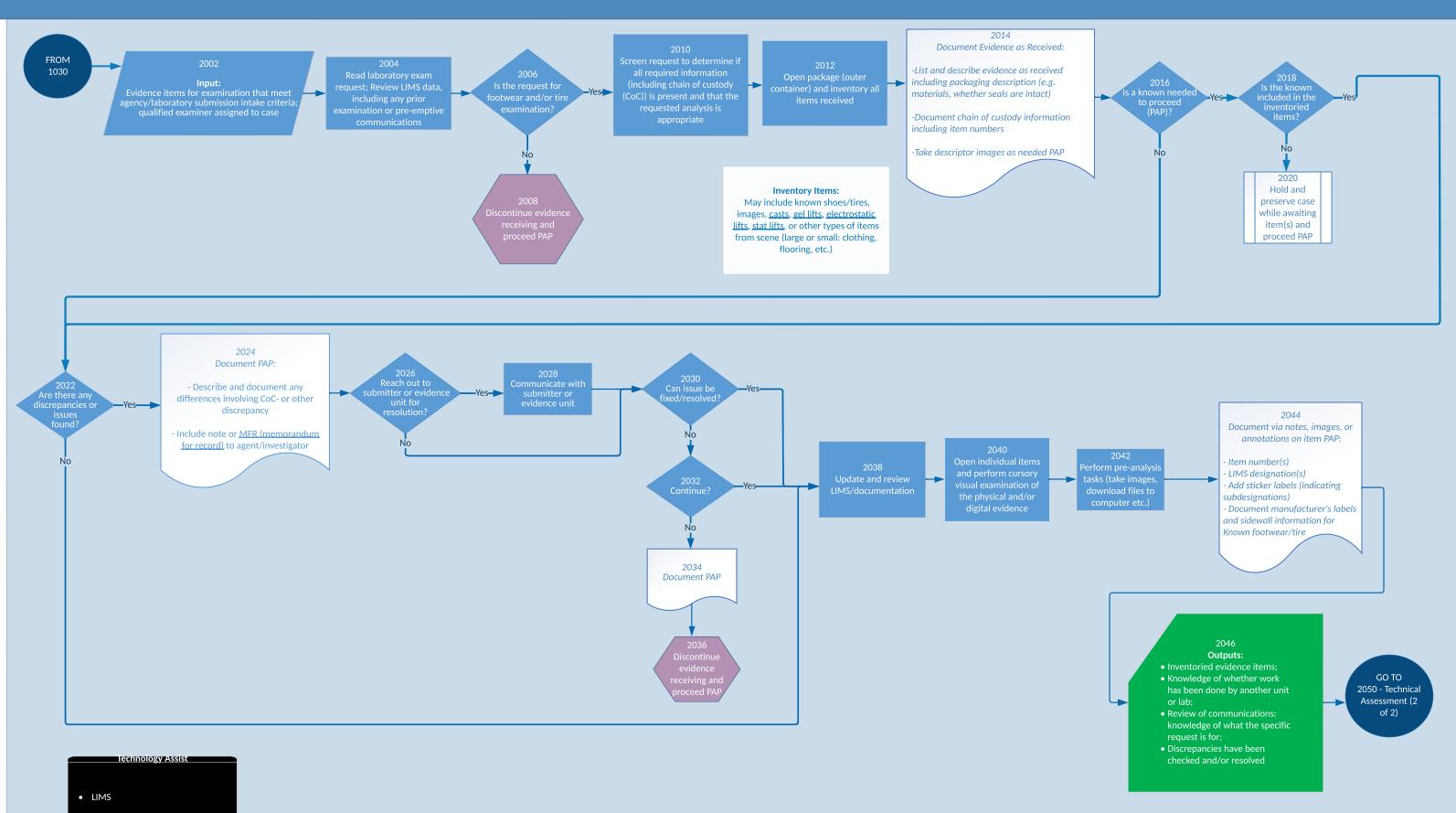
OSAC Footwear and Tire Subcommittee

1000 - Administrative Assessment

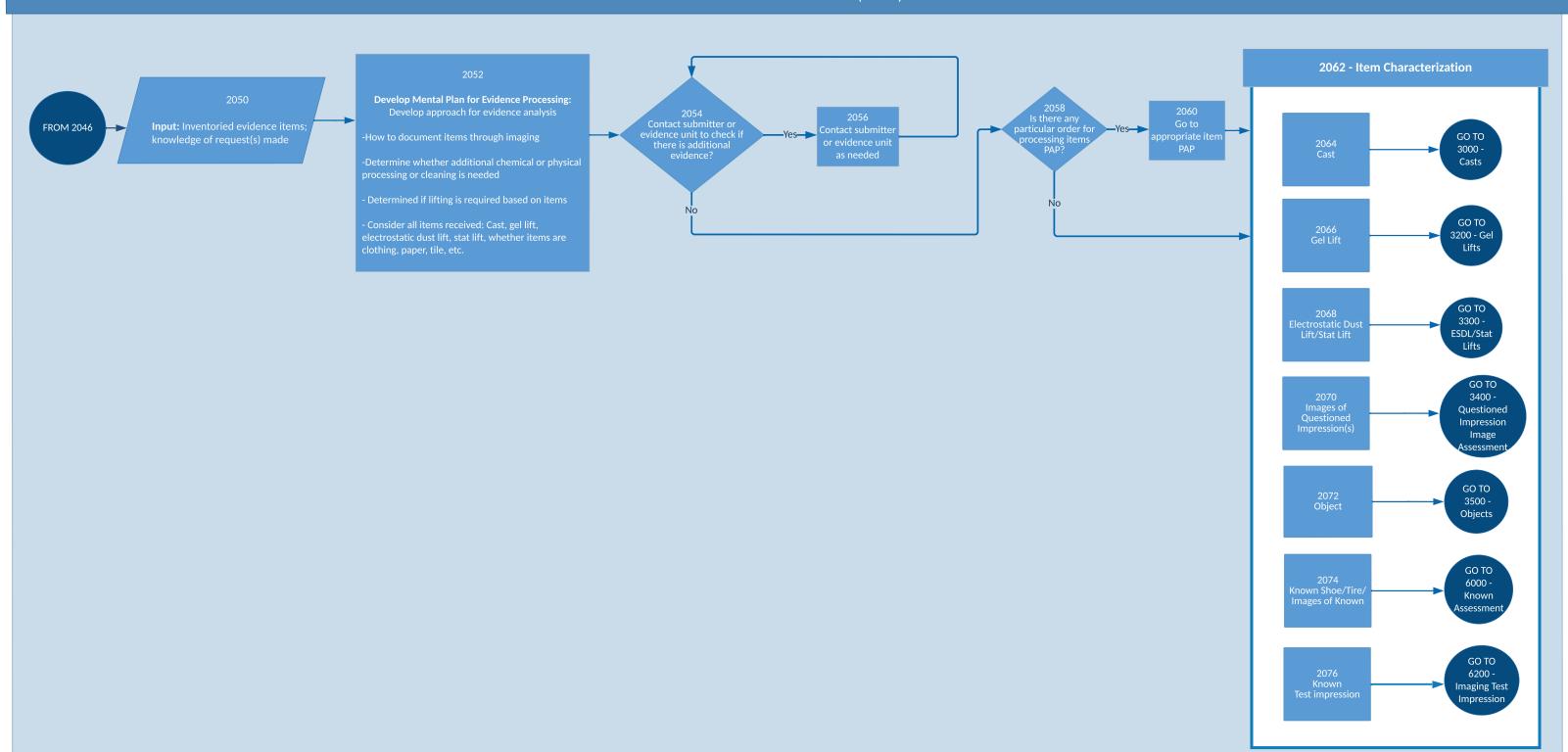




turn to Overview 2000 - Technical Assesment (1 of 2)



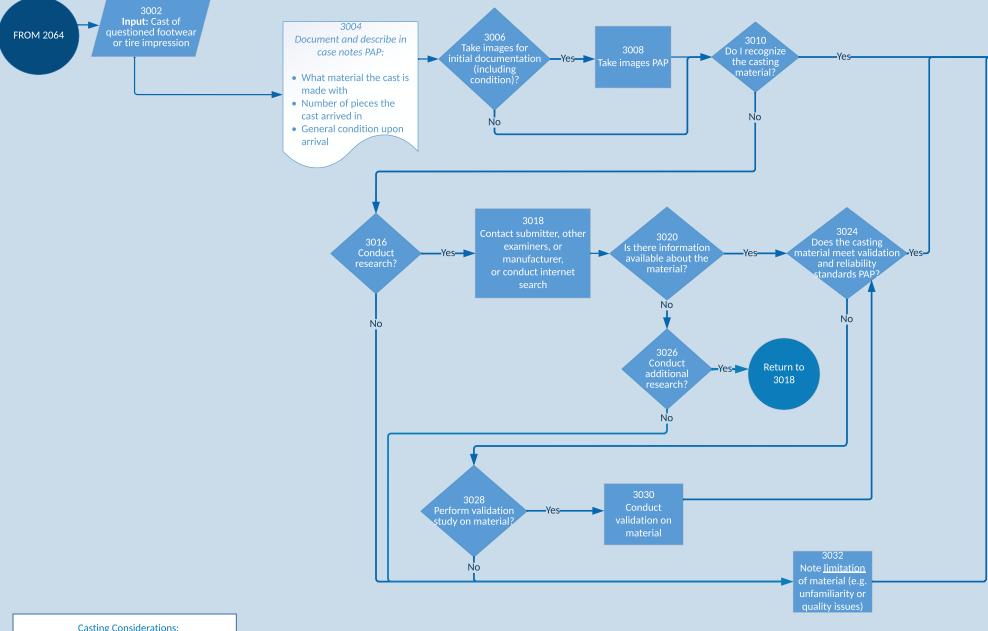
2000 - Technical Assessment (2 of 2)



GO TO 3040 Casts (2 of 2)

under drying lamp

3000 - Casts (1 of 3)



Casting Considerations: Descriptive Information

Orientation Marks

Scene Documentation Marks

Impression number on cast from scene

other items of evidence that have been submitted?

Casting Considerations:

Quality and Materials (potential limitations)

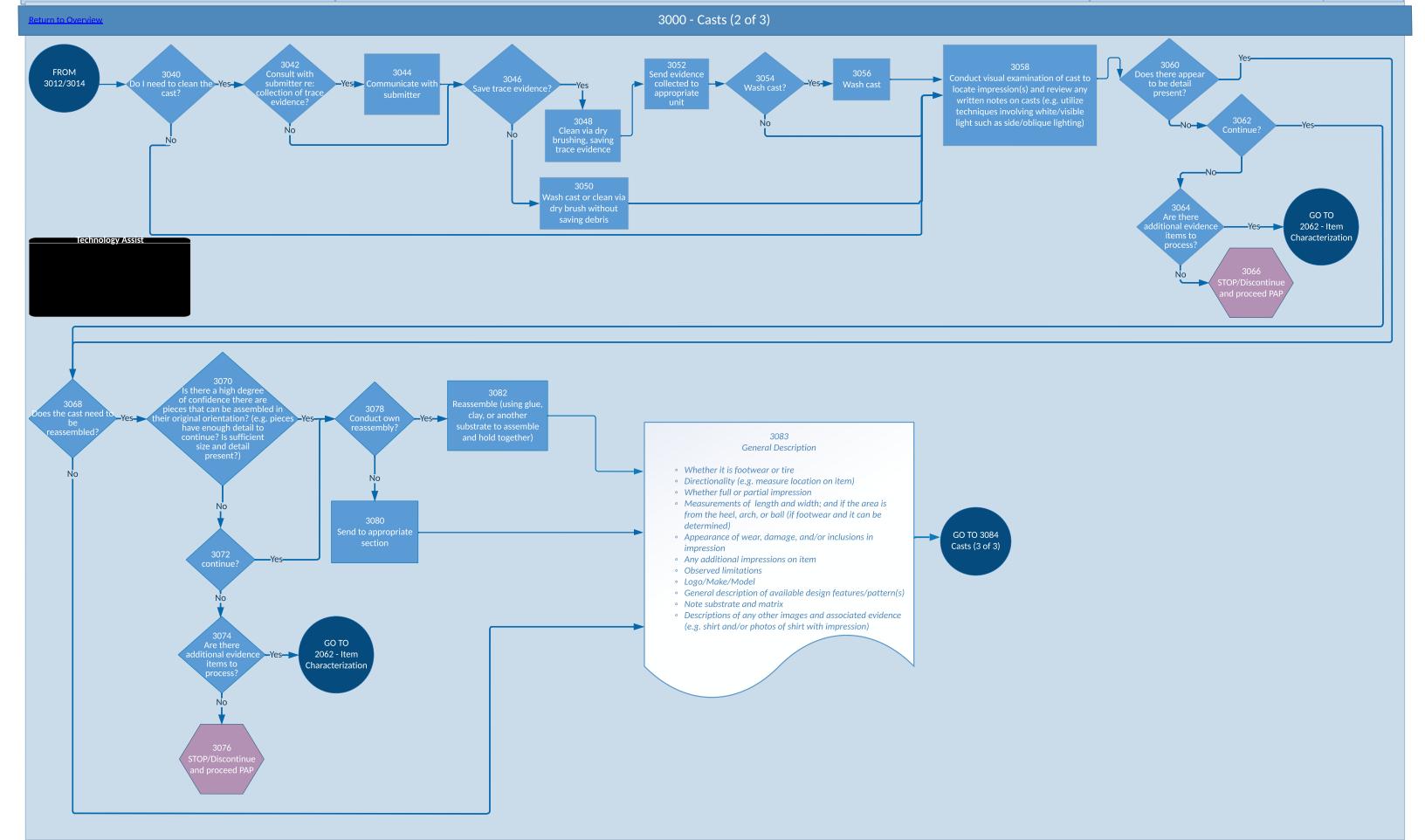
-Folds in cast present? -Features in cast that appear to be interferences from

the technique or substrate present?

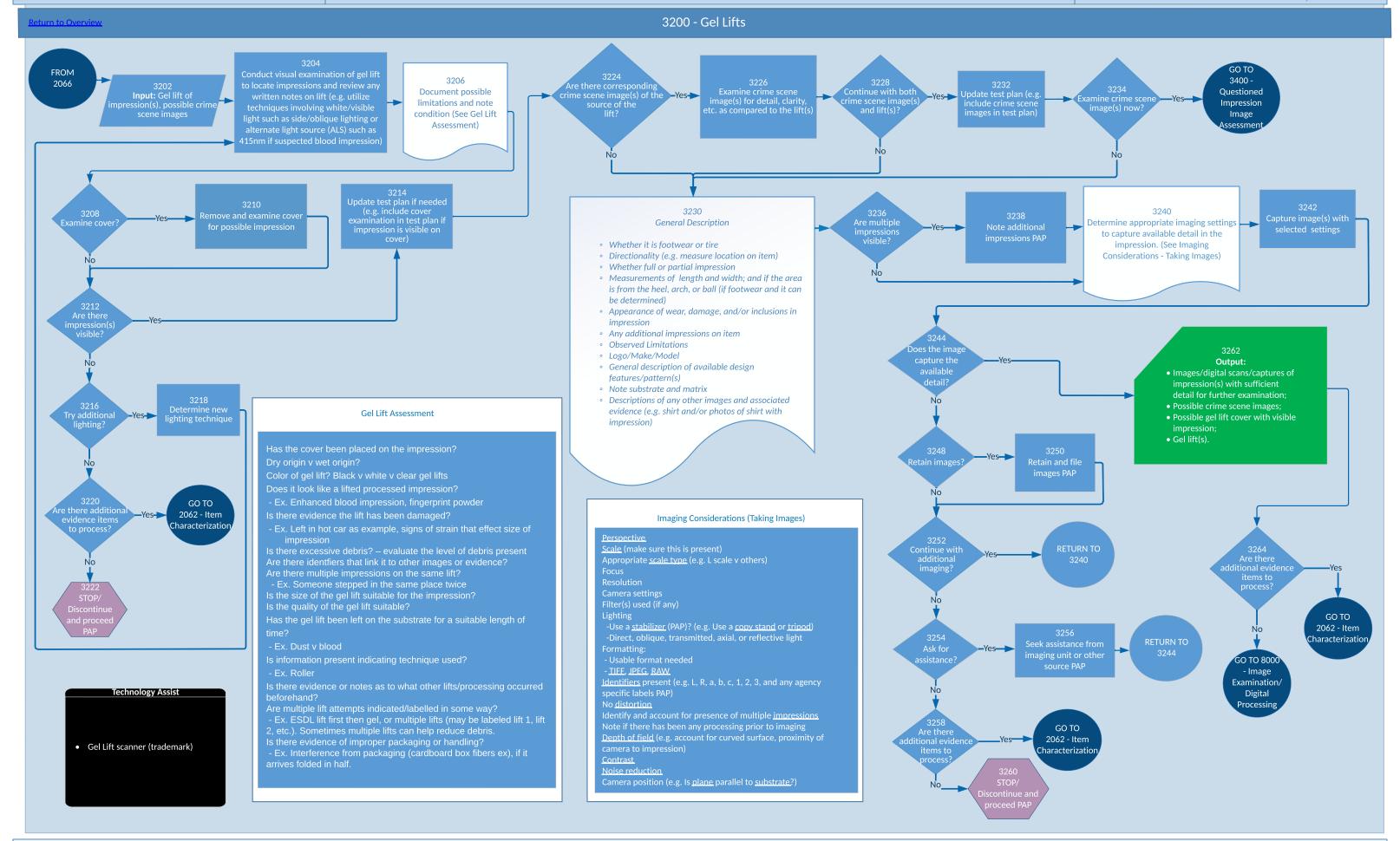
- Was a spray coating used? Is debris stuck in casting material?

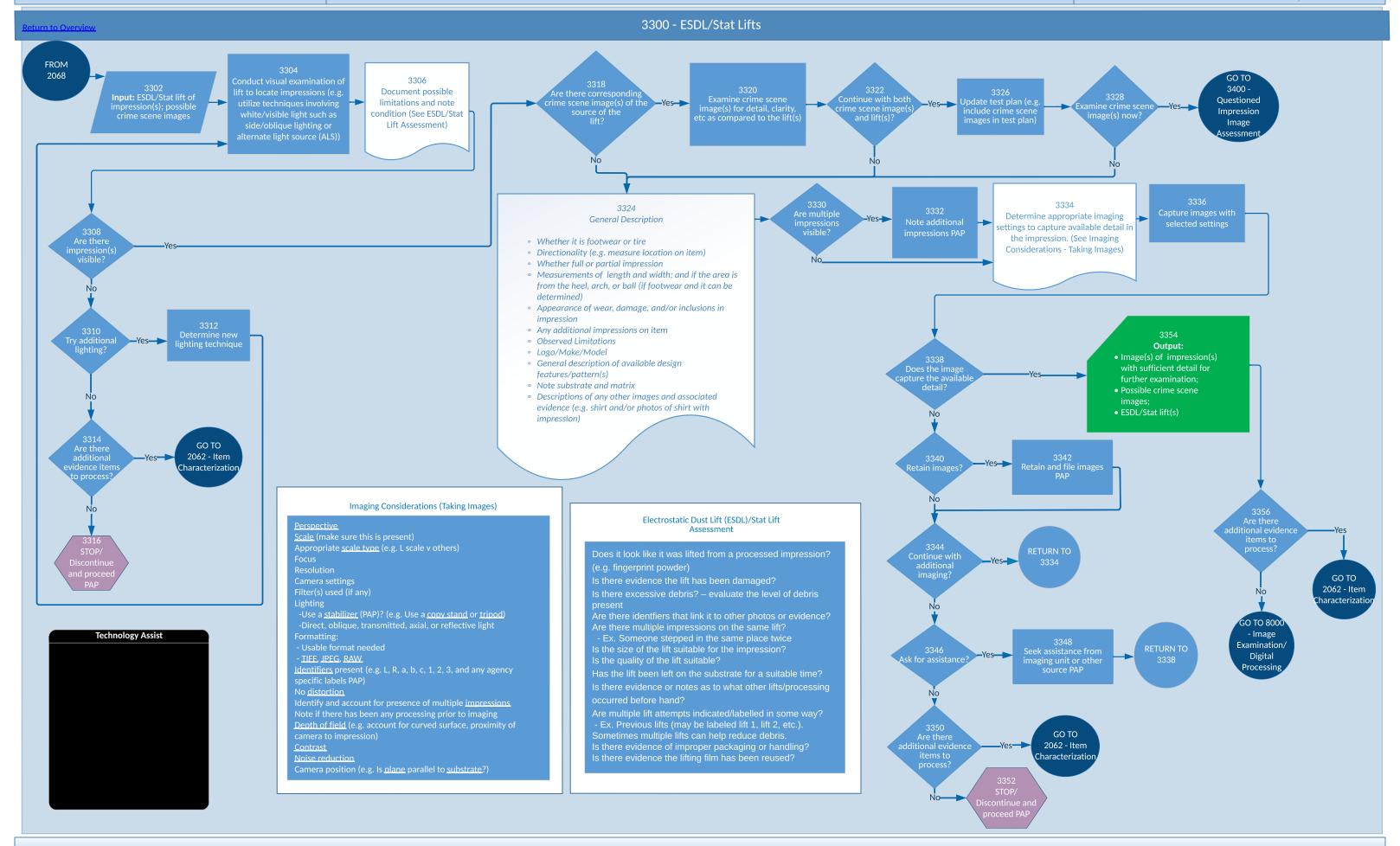
-Has the material been validated? (i.e. Has the material reliably captures size adn features accurately with no shrinking after drying etc.)
-Density: Too thick/thin?





3000 - Casts (3 of 3) 3090 Capture images Determine appropriate imaging settings to capture the available settings detail in the impression. (See **Imaging Considerations (Taking** Images)) 3086 Seek assistance from imaging unit or other source PAP 3088 Does the image apture the availa detail? 3106 Are there GO TO **Output:** 2062 - Item • Image(s) that contain sufficient Characterization detail for digital processing; Clean cast, Pieces of/partial cast, or reassembled cast GO TO 8000 • Knowledge of any potential - Image limitations of casting material. Examination/ Digital Processing 3096 Retain and file images PAP 3094 Retain images? Imaging Considerations (Taking Images) Appropriate scale type (e.g. L scale v others) Camera settings Filter(s) Used (if any) -Use a <u>stabilizer</u> (PAP)? (e.g. Use a <u>copy stand</u> or <u>tripod</u>) GO TO 2062 - Item Formatting: - Usable format needed Characterizatio <u>Identifiers</u> Present (e.g. L, R, a, b, c, 1, 2, 3, and any agency specific labels PAP) No <u>distortion</u> Identify and account for presence of multiple <u>impressions</u> Note if there has been any processing prior to images (e.g. <u>Barriers</u> or <u>highlighters</u>: wax, spray) Depth of field (e.g. account for curved surface, proximity of Contrast Noise reduction Camera position (e.g. Is <u>plane</u> parallel to <u>substrate</u>?)





3400 - Questioned Impression Image Assessment

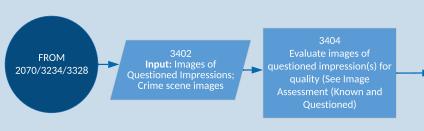


Image Assessment (Known and Questioned)

Scale type appropriate?

Need for <u>correction</u>? (e.g. perspective and potential correction in image processing software)

Focus
Lighting
Are all images present?

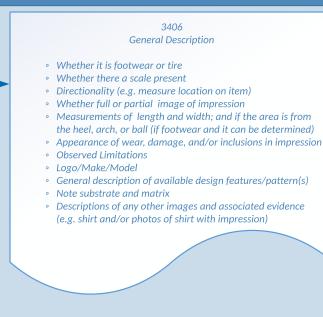
Exam grade v midrange v overall Image

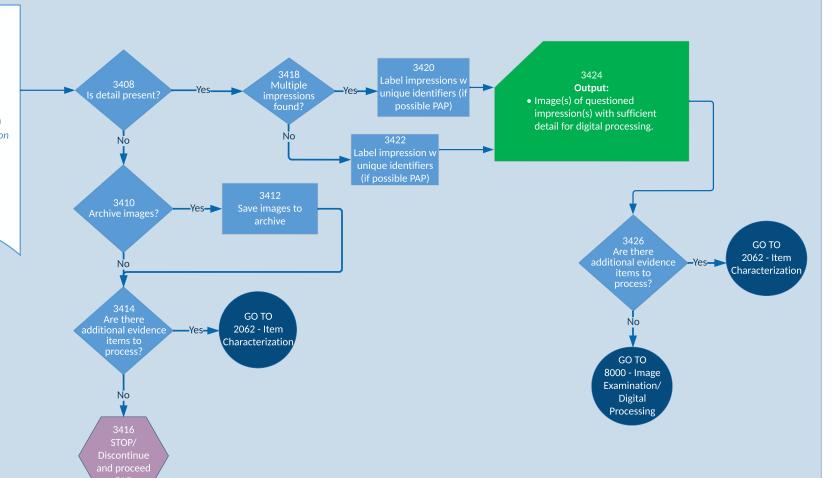
- <u>JPEG</u> v <u>RAW</u>

Distortion

Presence of peripheral impressions

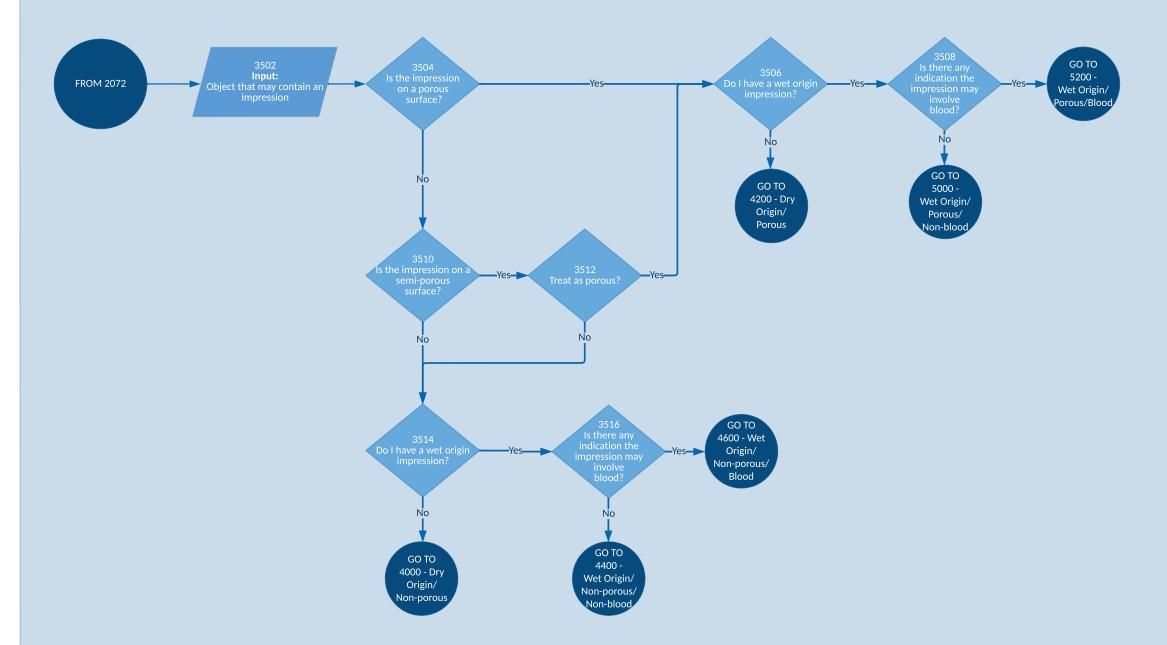
Has there been any processing prior to imaging? (e.g. <u>barriers</u> or <u>highlighters</u>: wax, spray)

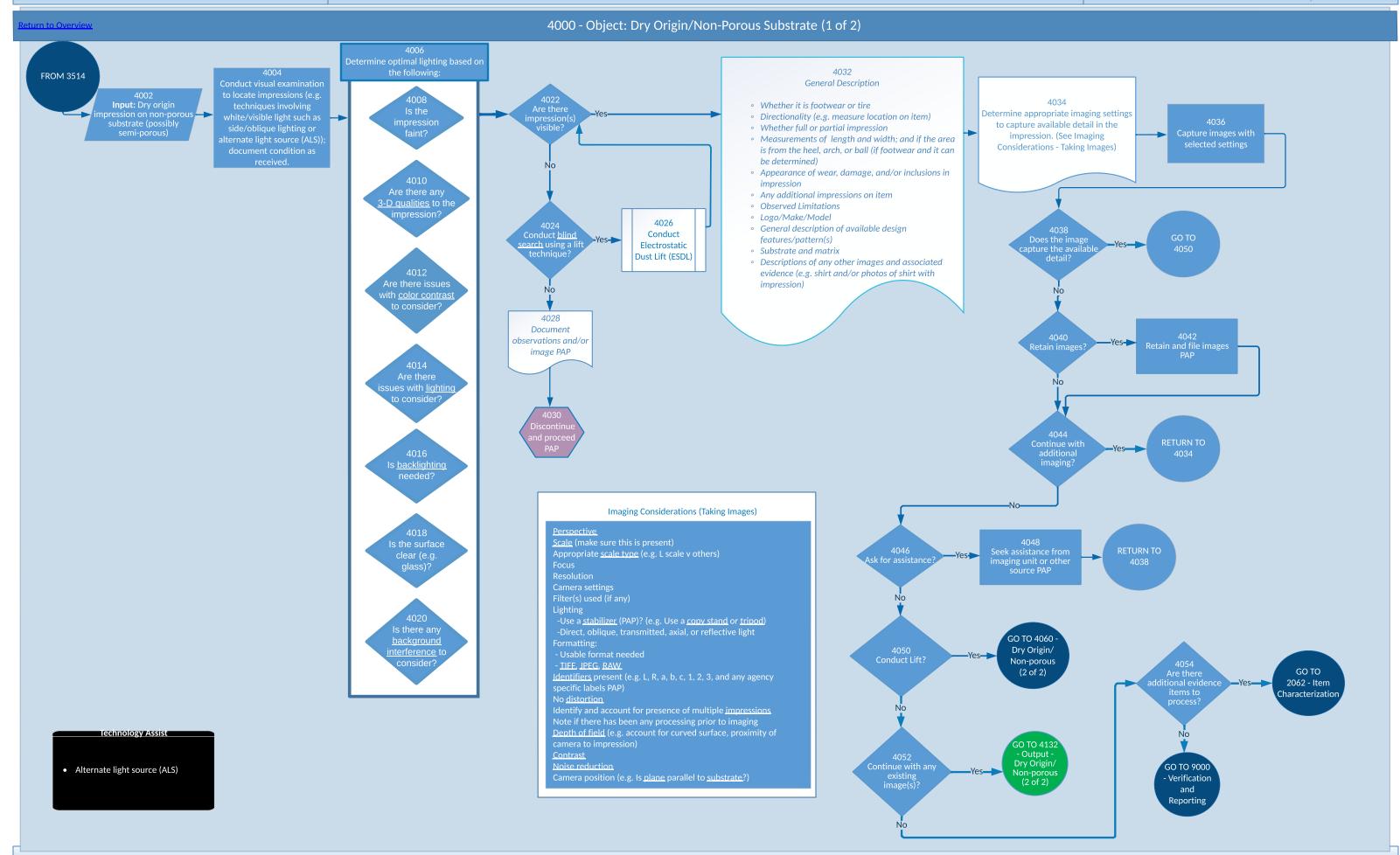




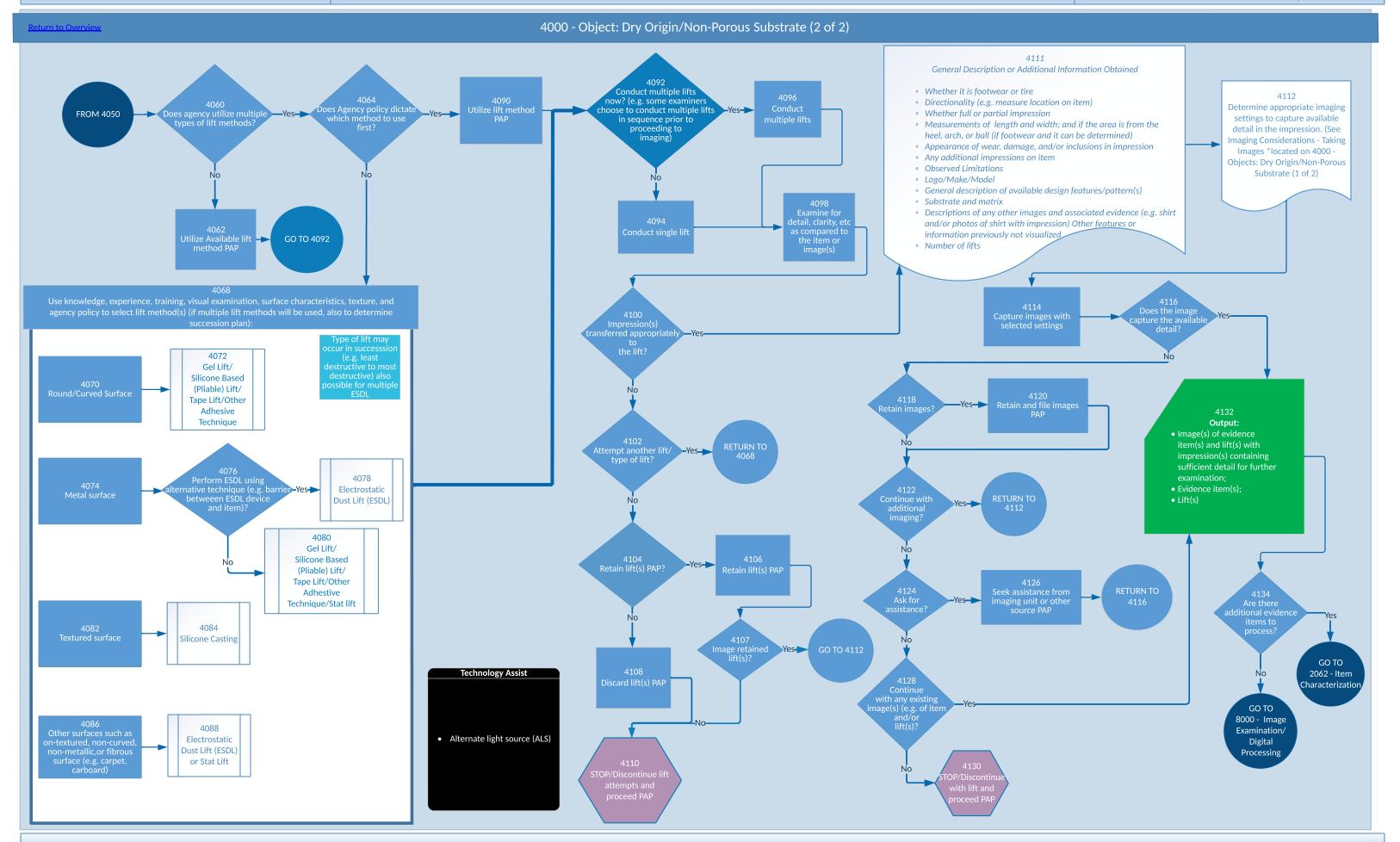
Technology Assist • Image processing software

Return to Overview 3500 - Objects

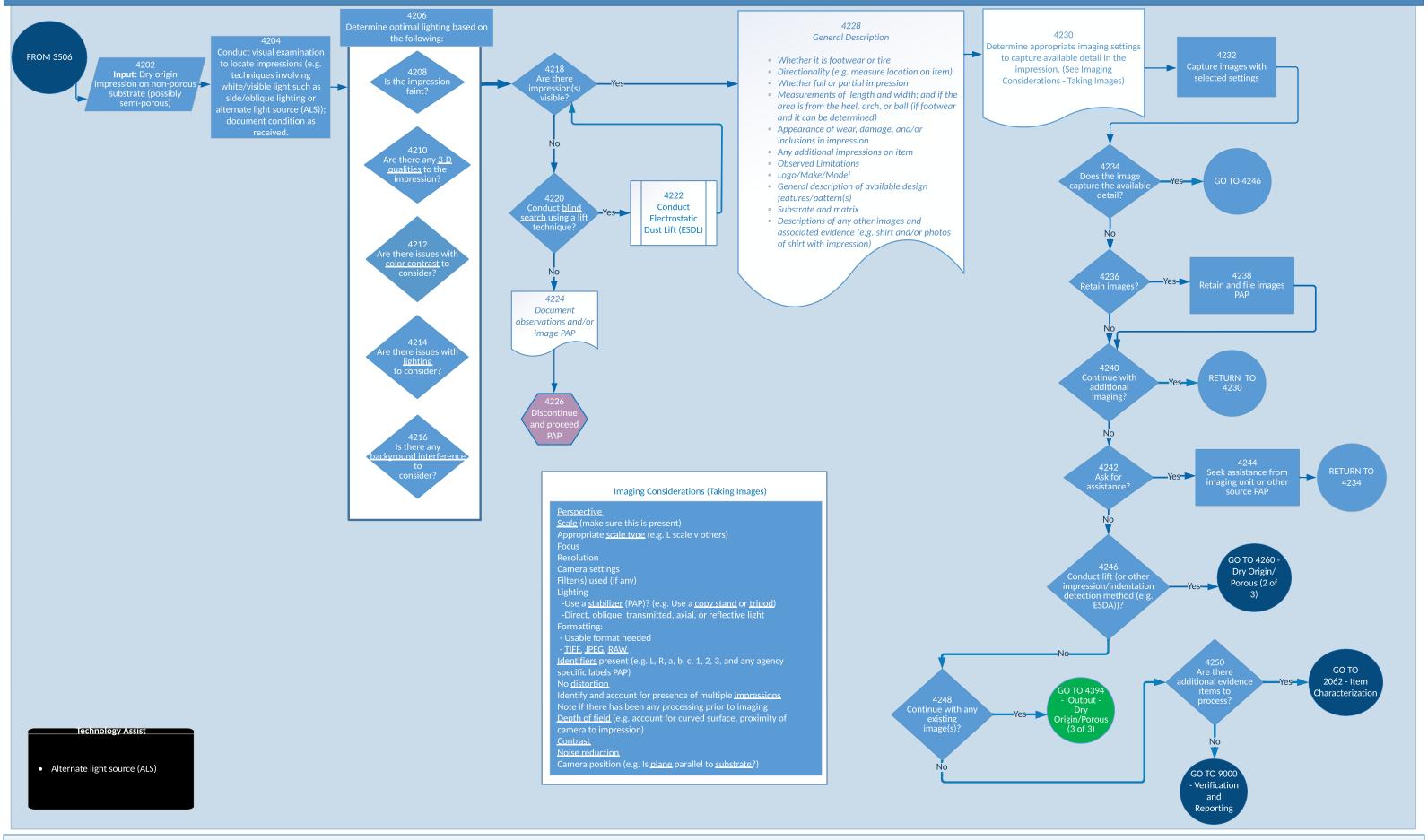


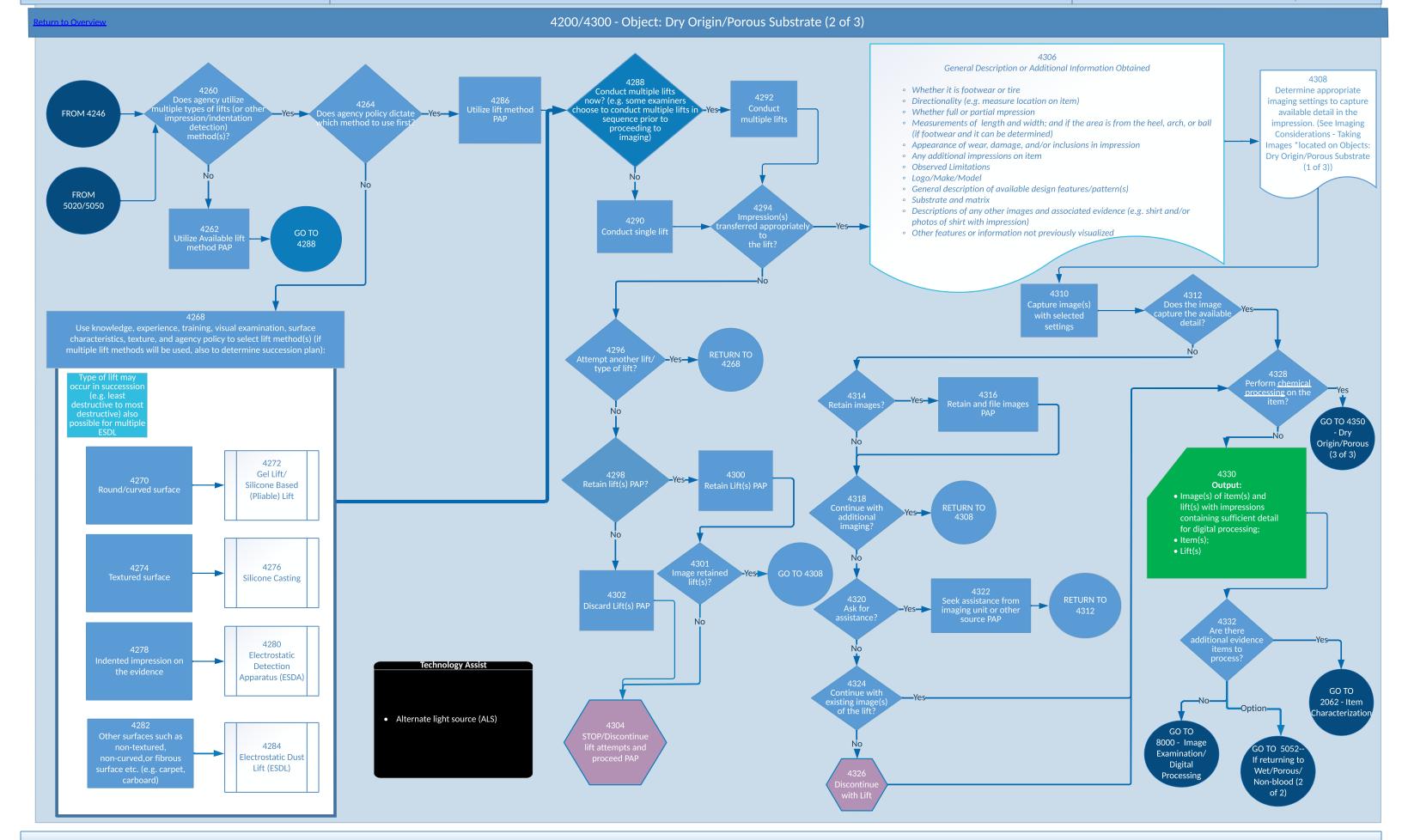


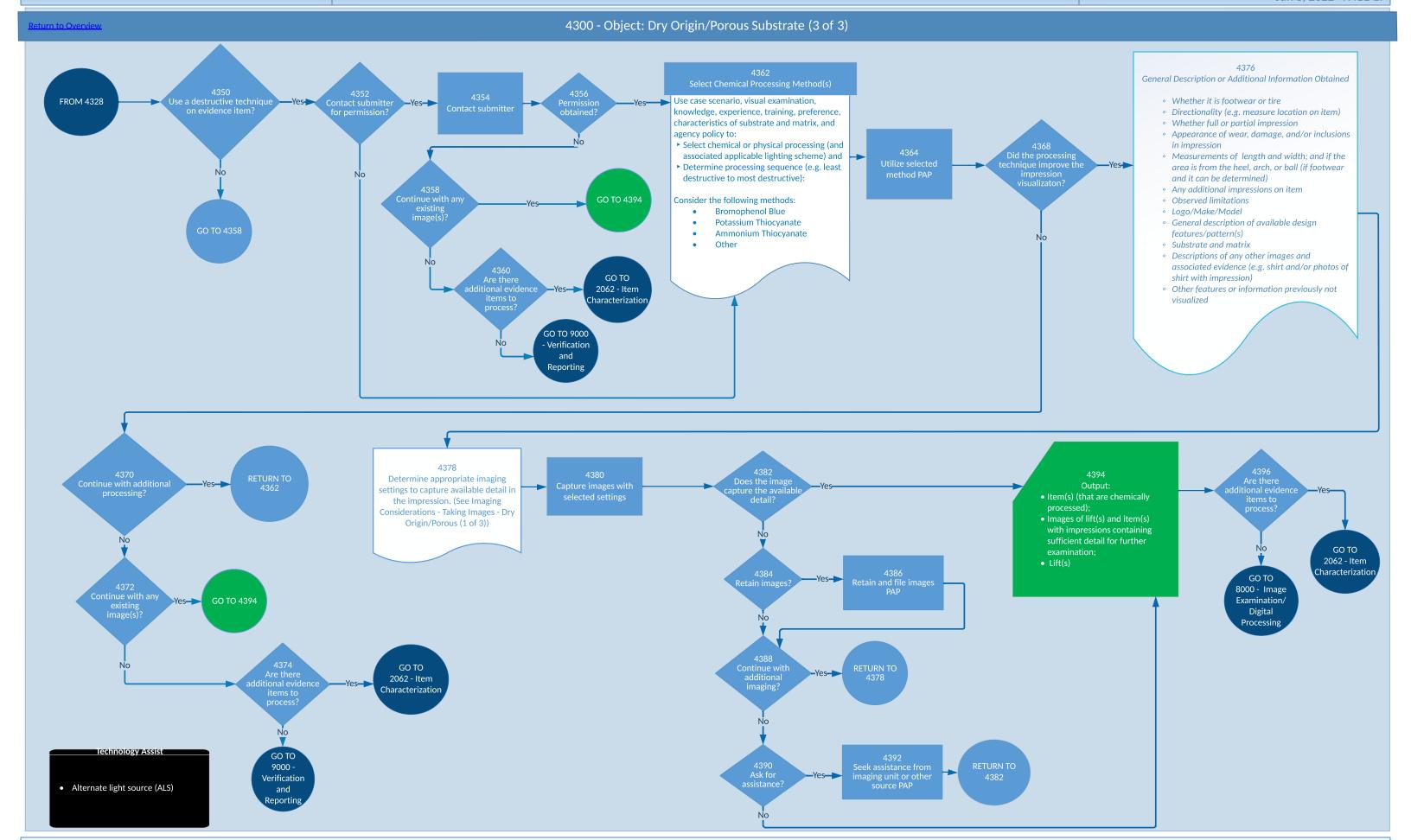
OSAC Footwear and Tire Subcommittee



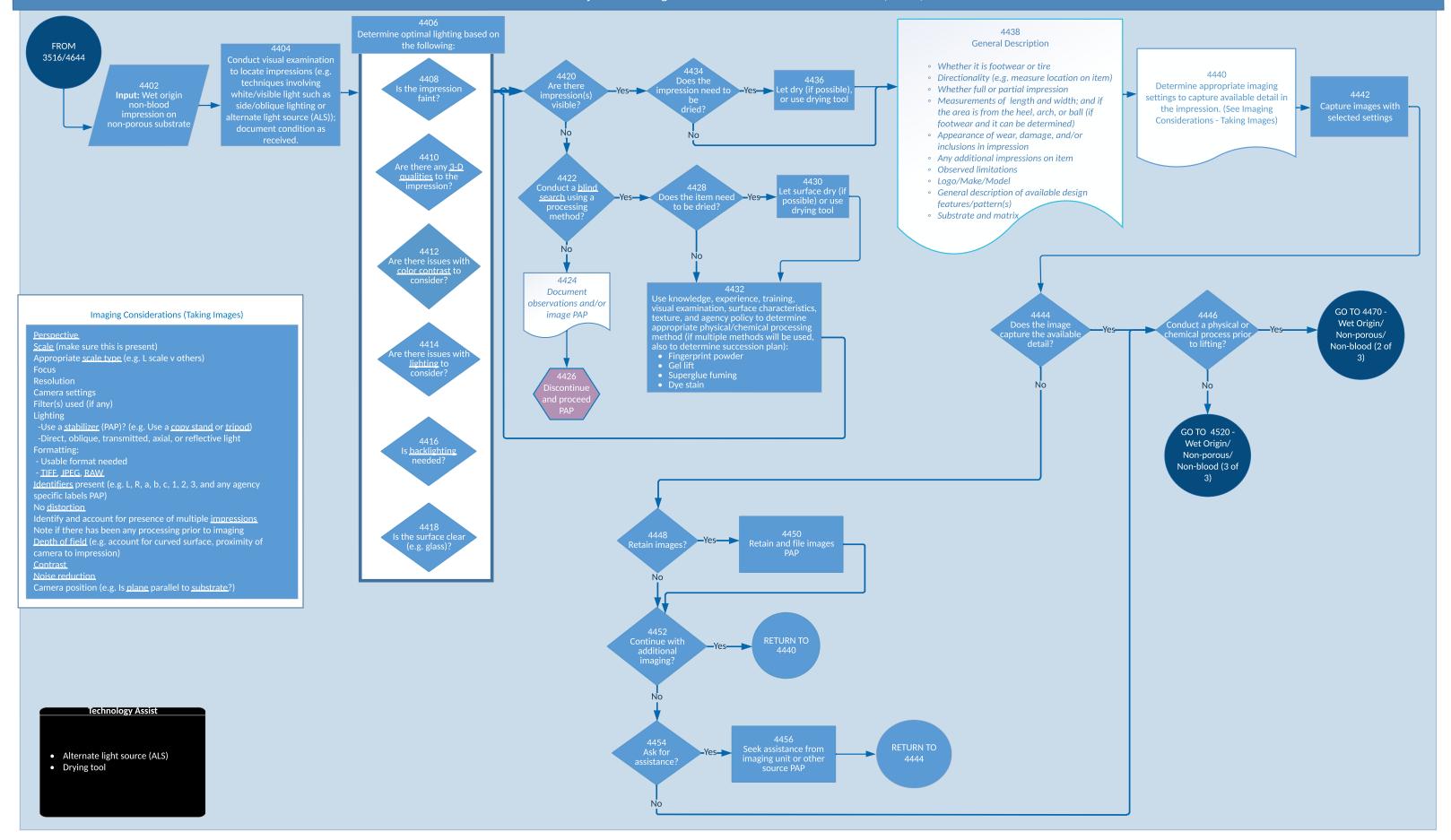
eturn to Overview 4200 - Object: Dry Origin/Porous Substrate (1 of 3)



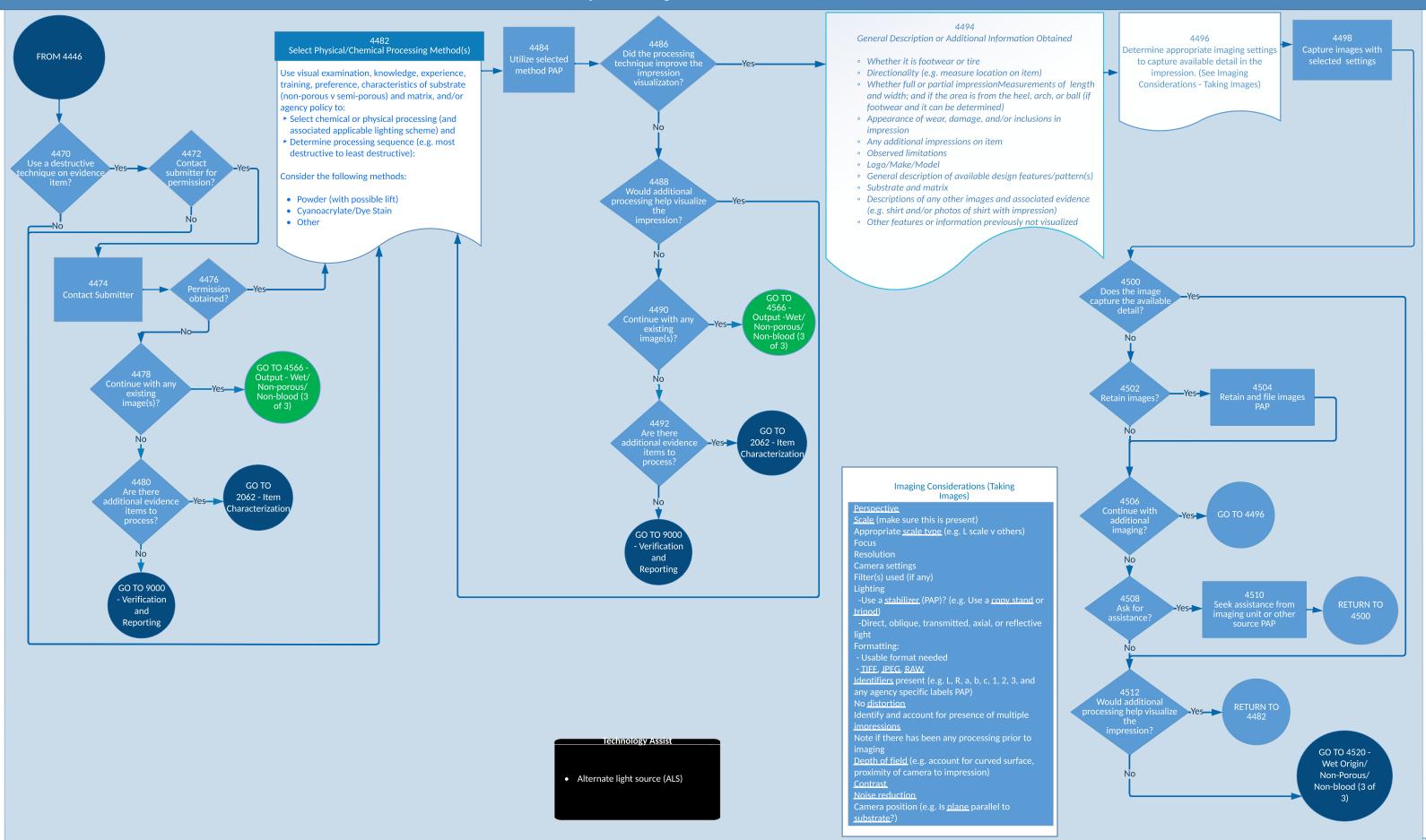




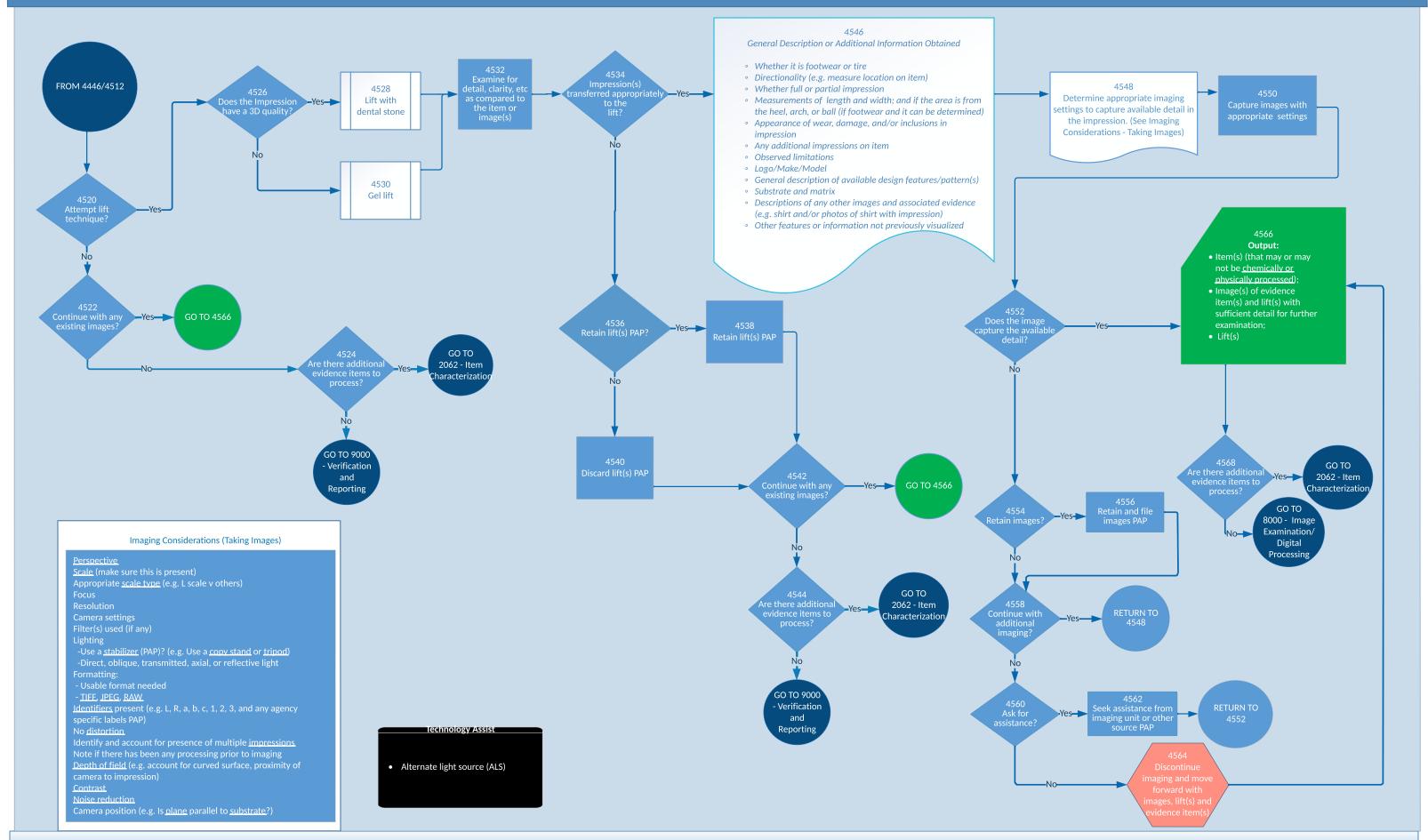
4400 - Object: Wet Origin/Non-Porous Substrate/Non-Blood (1 of 3)



4400/4500 - Object: Wet Origin/Non-Porous Substrate/Non-Blood (2 of 3)



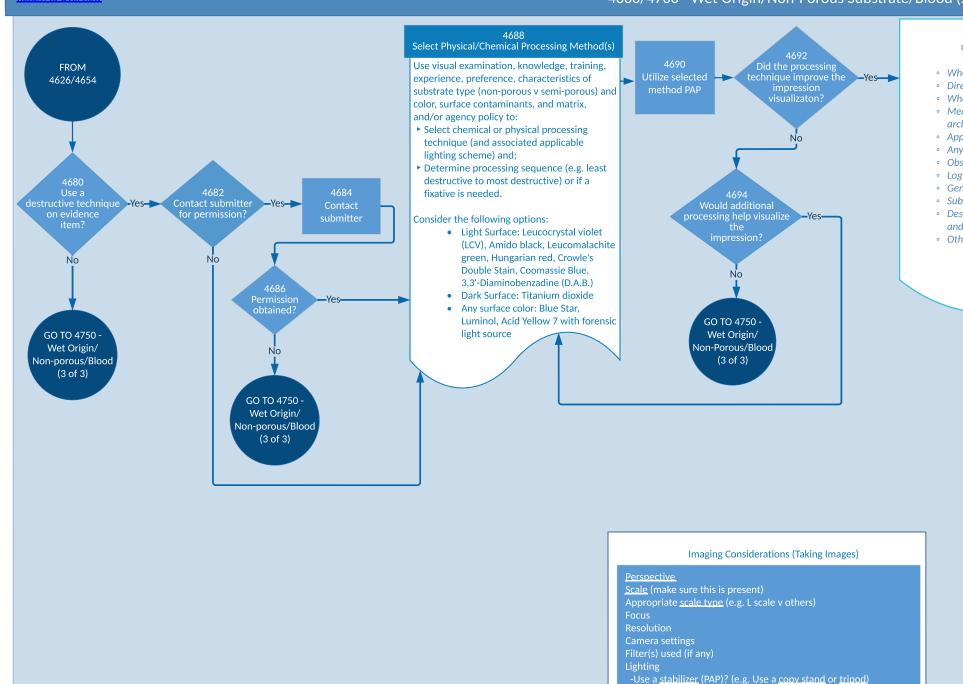
4500 - Object: Wet Origin/Non-Porous Substrate/Non-Blood (3 of 3)



4648

4600 - Wet Origin/Non-Porous Substrate/Blood (1 of 3) Determine optimal lighting based on the following: 4646 **General Description** FROM 3516 Whether it is footwear or tire Determine appropriate imaging • Directionality (e.g. measure location on settings to capture available detail in the impression. (See Imaging • Whether full or partial impression to locate impressions (e.g. Considerations - Taking Images) • Measurements of length and width; and if techniques involving Input: Blood Impression the area is from the heel, arch, or ball (if white/visible light such as footwear and it can be determined) side/oblique lighting or ternate light source (ALS)) document condition as Appearance of wear, damage, and/or inclusions in impression Any additional impressions on item Observed Limitations Logo/Make/Model • General description of available design GO TO 4680 features/pattern(s) Wet Origin/ Substrate and matrix Non-porous/ Descriptions of any other images and selected settings Blood (2 of 3) 4628 associated evidence (e.g. shirt and/or Document photos of shirt with impression) bservations and/or image PAP GO TO 4400 -Wet/non-porou Non-blood GO TO 4680 -Wet Origin/ Non-porous/ apture the ava detail? Blood (2 of 3) Imaging Considerations (Taking Images) Appropriate <u>scale type</u> (e.g. L scale v others) 4658 Retain and file images GO TO 4750 -Wet Origin/ Non-porous/Blood (3 of 3) -Use a stabilizer (PAP)? (e.g. Use a copy stand or formatting: - Usable format needed TIFE, JPEG, RAW RETURN TO 4648 dentifiers present (e.g. L, R, a, b, c, 1, 2, 3, and any Technology Assist Note if there has been any processing prior to imaging <u>Depth of field</u> (e.g. account for curved surface, 4662 Ask for Drying tool Seek assistance from imaging unit or other Noise reduction • Alternate light source (ALS)

4600/4700 - Wet Origin/Non-Porous Substrate/Blood (2 of 3)



4696 General Description or Additional Information Obtained

- Whether it is footwear or tire
- Directionality (e.g. measure location on item)
- Whether full or partial impression
- Measurements of length and width; and if the area is from the heel, arch, or ball (if footwear and it can be determined)
- Appearance of wear, damage, and/or inclusions in impression
- Any additional impressions on item
- Observed limitations
- Logo/Make/Model
- General description of available design features/pattern(s)
- Substrate and matrix
- Descriptions of any other images and associated evidence (e.g. shirt and/or photos of shirt with impression)

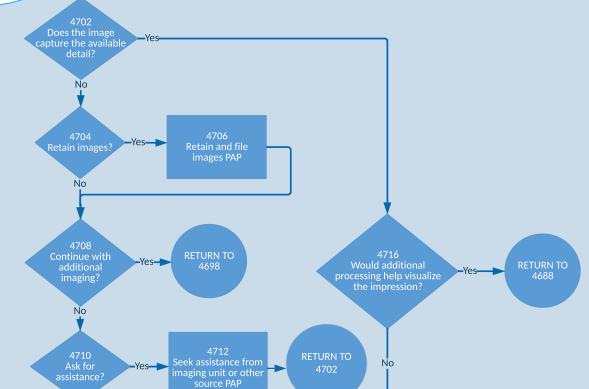
nduct any addition processing?

Other features or information not previously visualized

4698
Determine appropriate imaging settings to capture available detail in the impression. (See Imaging Considerations - Taking Images)

4700
Capture images with selected settings

GO TO 4750 -Wet Origin/ Non-Porous/Bloo (3 of 3)



RETURN TO

Technology Assist

• Alternate light source (ALS)

Noise reduction

- <u>TIFE</u>, <u>JPEG</u>, <u>RAW</u>

Camera position (e.g. Is <u>plane</u> parallel to <u>substrate</u>?)

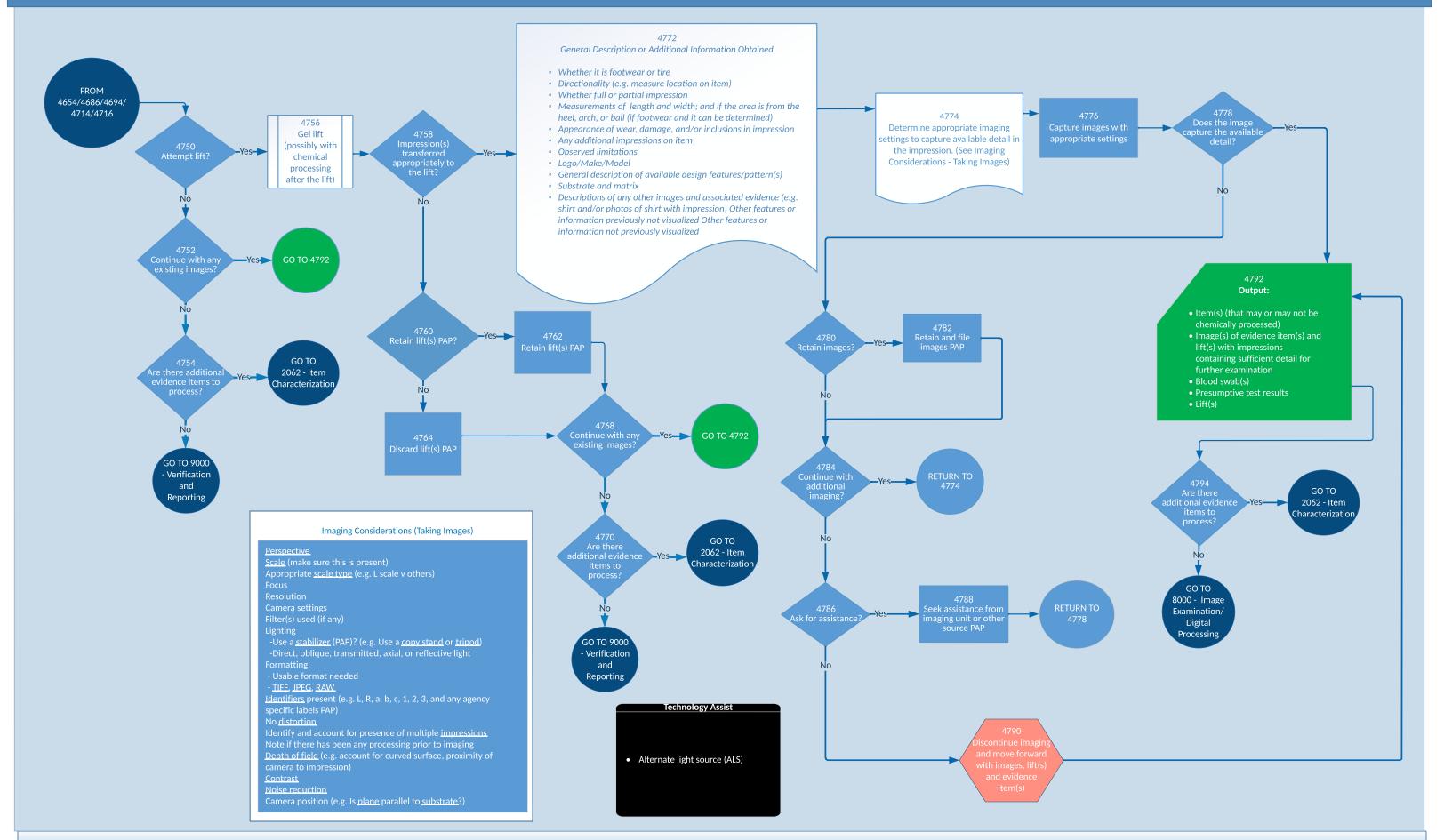
-Direct, oblique, transmitted, axial, or reflective light

<u>Identifiers</u> present (e.g. L, R, a, b, c, 1, 2, 3, and any agency specific labels PAP)

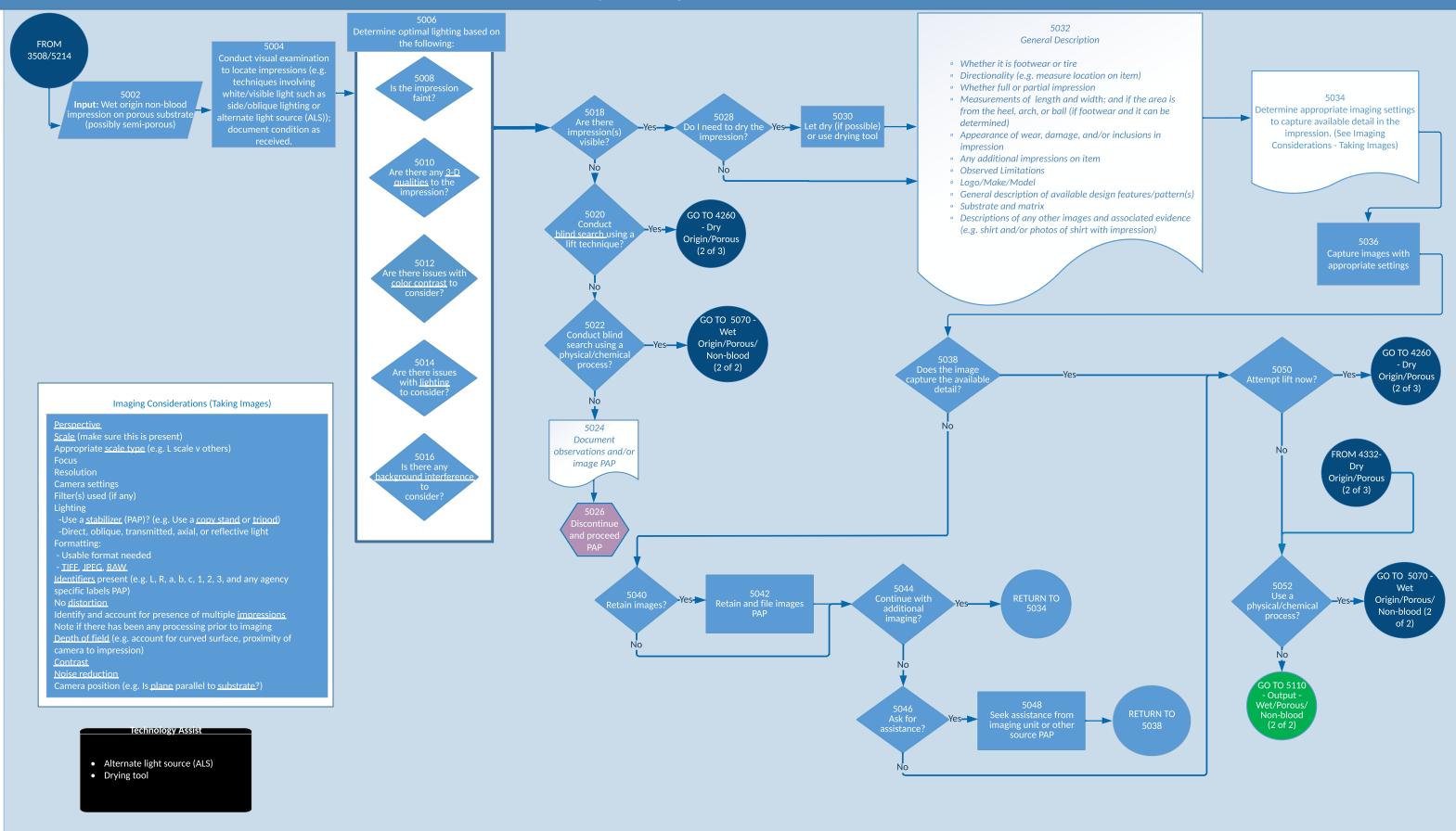
Identify and account for presence of multiple <u>impressions</u> Note if there has been any processing prior to imaging

<u>Depth of field</u> (e.g. account for curved surface, proximity of camera to impression)

4700 - Object: Wet Origin/Non-Porous Substrate/Blood (3 of 3)

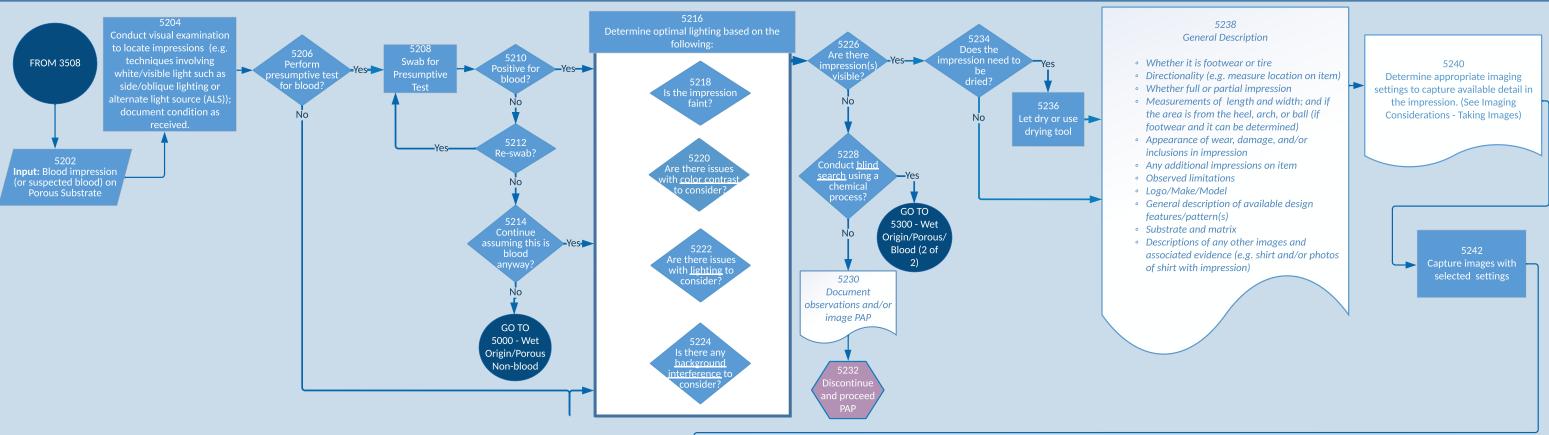


5000 - Object: Wet Origin/Porous Substrate/Non-Blood (1 of 2)



5000 - Object: Wet Origin/Porous Substrate/Non-Blood (2 of 2) Select Physical/Chemical Processing Method(s) 5092 General Description or Additional Information Obtained Use visual examination, knowledge, training, experience, FROM preference, characteristics of substrate type (non-porous 5022/5052 Whether it is footwear or tire submitter fo v semi-porous) and color, surface contaminants, and • Directionality (e.g. measure location on item) matrix, and/or agency policy to: • Whether full or partial impressionMeasurements of length and width; and if the area is from the heel, arch, or ball (if footwear and it can be determined) ► Select chemical or physical processing technique (and • Appearance of wear, damage, and/or inclusions in impression associated applicable lighting scheme) and; Anv additional impressions on item Determine processing sequence (e.g. least destructive Observed limitations to most destructive) and if a fixative is needed. Logo/Make/Model • General description of available design features/pattern(s) Consider the following options: Substrate and matrix • Iodine (for lipids, documents) • Descriptions of any other images and associated evidence (e.g. shirt and/or Potassium Thiocyanate photos of shirt with impression) Fingerprint powder Did the processing Other features or information not previously visualized Amido Black Ninhvdrin • 1,2 Indanedione- Zinc Chloride DFO Silver Nitrate/Physical Developer Other 5094 GO TO 5088 Determine appropriate imaging settings to capture available detail in the impression. (See Imaging Considerations - Taking Images) 5098 Does the ima **Output:** RETURN TO 5080 • Item(s) (that are chemically processed); 5112 Are there • images of item(s) with Imaging Considerations (Taking Images) GO TO impressions containing 2062 - Item naracterizatio Scale (make sure this is present) examination Appropriate <u>scale type</u> (e.g. L scale v others) GO TO 5102 Retain and file image 5100 Retain imag 8000 - Image Examination/ Digital 5088 Continue with any GO TO 5110 -Use a <u>stabilizer</u> (PAP)? (e.g. Use a <u>copy stand</u> or <u>tripod</u>) xisting images -Direct, oblique, transmitted, axial, or reflective light Technology Assist Identifiers present (e.g. L, R, a, b, c, 1, 2, 3, and any agency No <u>distortion</u> Identify and account for presence of multiple impressions Alternate light source (ALS) GO TO Note if there has been any processing prior to imaging Depth of field (e.g. account for curved surface, proximity of 2062 - Item Characterization Contrast Seek assistance from imaging unit or other GO TO 9000 -Camera position (e.g. Is <u>plane</u> parallel to <u>substrate</u>?) Verification and Reporting

5200 - Object: Wet Origin/Porous Substrate/Blood (1 of 2)



Imaging Considerations (Taking Images)

Appropriate <u>scale type</u> (e.g. L scale v others)

Camera settings

-Use a <u>stabilizer</u> (PAP)? (e.g. Use a <u>copy stand</u> or <u>tripod</u>) -Direct, oblique, transmitted, axial, or reflective light

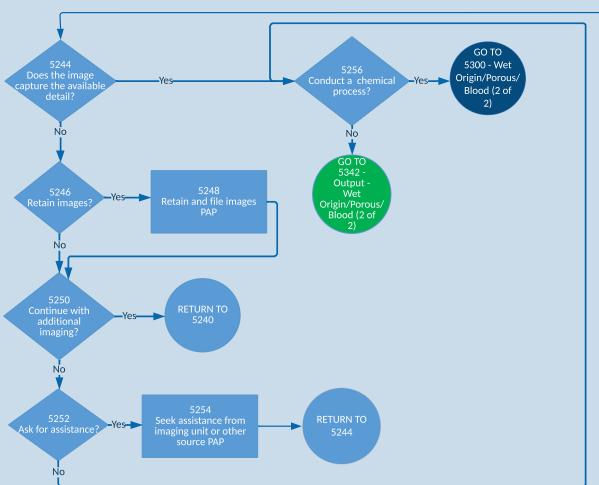
- <u>TIFE</u>, <u>JPEG</u>, <u>RAW</u>

<u>Identifiers</u> present (e.g. L, R, a, b, c, 1, 2, 3, and any agency specific labels PAP)

Identify and account for presence of multiple impressions Note if there has been any processing prior to imaging Depth of field (e.g. account for curved surface, proximity of

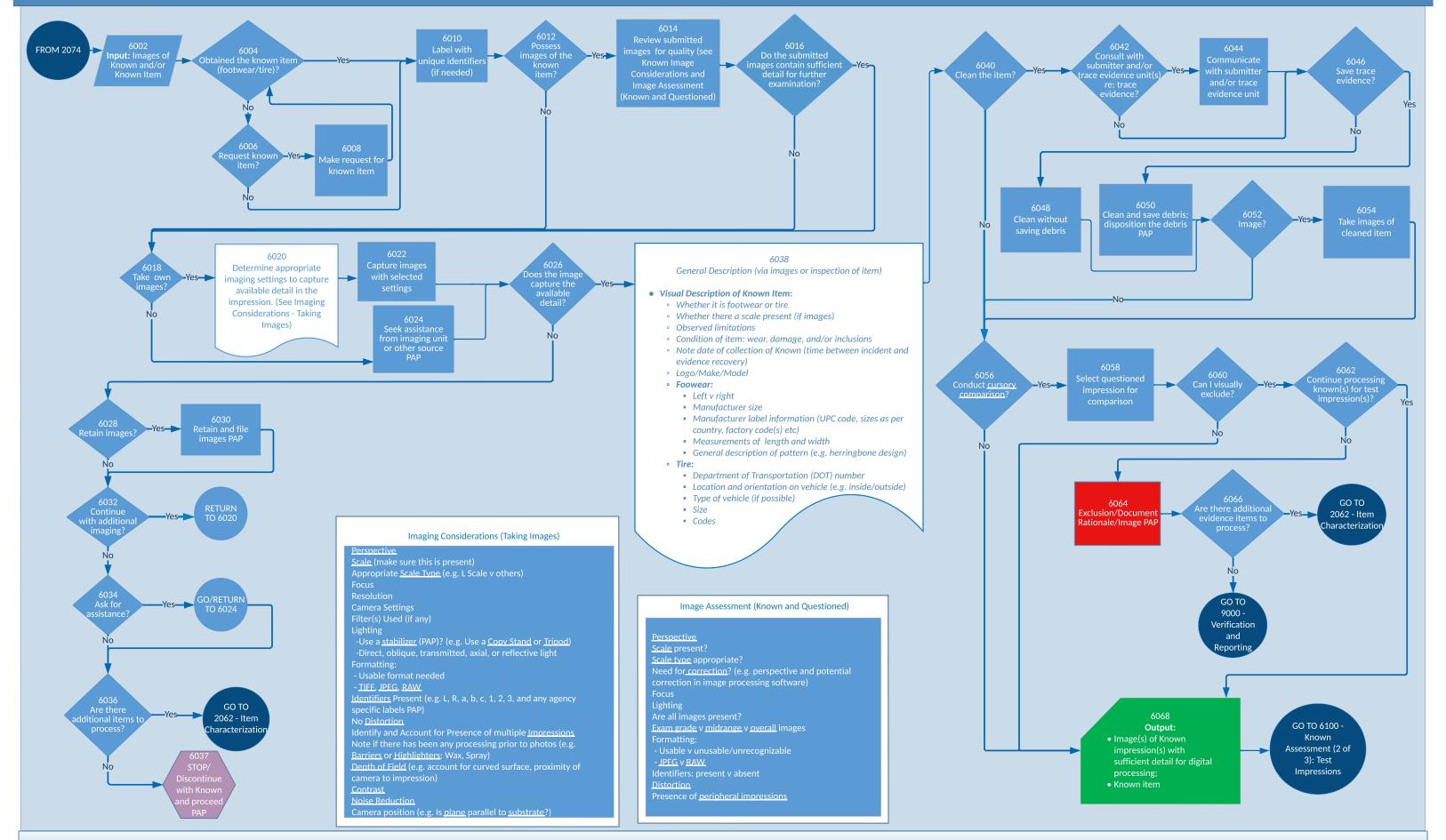
Camera position (e.g. Is <u>plane</u> parallel to <u>substrate</u>?)



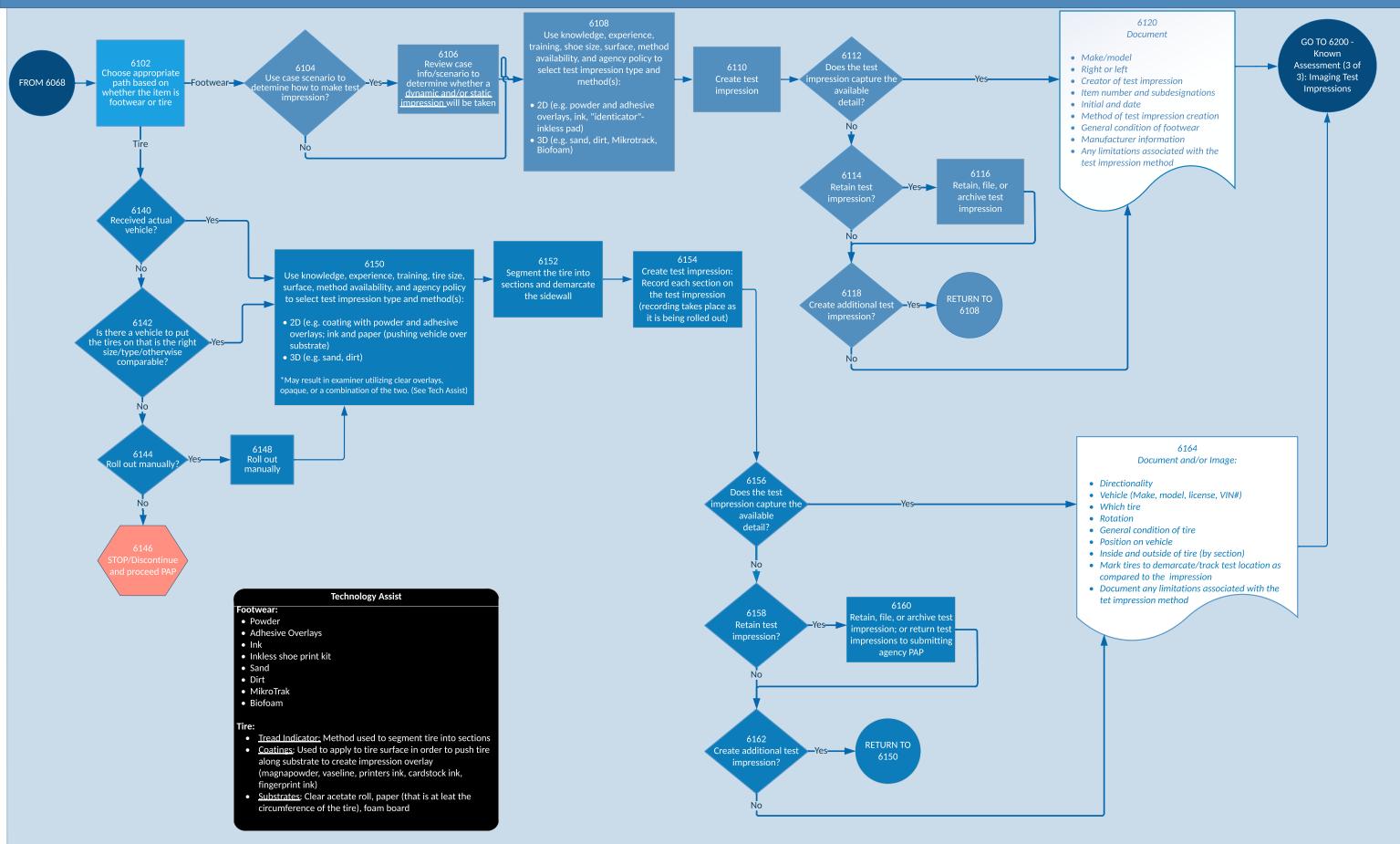


turn to Overview 5300 - Object: Wet Origin/Porous Substrate/Blood (2 of 2) 5310 Select Chemical Processing Method(s) General Description or Additional Information Obtained 5304 Contact Use visual examination, knowledge, experience, training, FROM Whether it is footwear or tire preference, characteristics of substrate and matrix, surface 5228/5256 • Directionality (e.g. measure location on item) contaminants, and/or agency policy to: Whether full or partial impression ► Select chemical or physical processing (and associated • Measurements of length and width; and if the area is applicable lighting scheme) and from the heel, arch, or ball (if footwear and it can be Determine processing sequence (e.g. least to most destructive). • Appearance of wear, damage, and/or inclusions in impression Consider the following options: • Any additional impressions on item • -1,2-Indanedione Zinc Chloride or DFO Observed limitations (1,8-Diazafluoren-9-one) with Forensic Light Source Logo/Make/Model Ninhvdrin GO TO 5318 Leucocrystal Violet (LCV)Physical Developer/Silver Nitrate · General description of available design GO TO 5318 features/pattern(s) Coomassie Blue Substrate and matrix • Crowle's Double Stain • Descriptions of any other images and associated evidence • Other (e.g. Blue Star, Luminol) (e.g. shirt and/or photos of shirt with impression) Other features or information not previously visualized 5330 Would furthe 5324 Output: RETURN TO 5310 Determine appropriate imaging • Item(s) (that may or may not settings to capture available detail ir be chemically processed); RETURN TO 5310 • Images of item(s) with the impression. (See Imaging Considerations - Taking Images) impressions containing examination Retain and file images PAP Imaging Considerations (Taking Images) Appropriate <u>scale type</u> (e.g. L scale v others) GO TO 2062 - Item GO TO 5342 Continue with an Characterization xisting images GO TO -Use a <u>stabilizer</u> (PAP)? (e.g. Use a <u>copy stand</u> or <u>tripod</u>) 8000 - Image Examination/ Digital Processing - <u>TIFF</u>, <u>JPEG</u>, <u>RAW</u> GO TO Identifiers present (e.g. L, R, a, b, c, 1, 2, 3, and any agency 2062 - Item specific labels PAP) 5338 Ask for **RETURN TO** Technology Assist haracterizatio Identify and account for presence of multiple impressions GO TO Note if there has been any processing prior to imaging Depth of field (e.g. account for curved surface, proximity of 9000 -Verification • Alternate light source (ALS) and Contrast Reporting Camera position (e.g. Is <u>plane</u> parallel to <u>substrate</u>?)

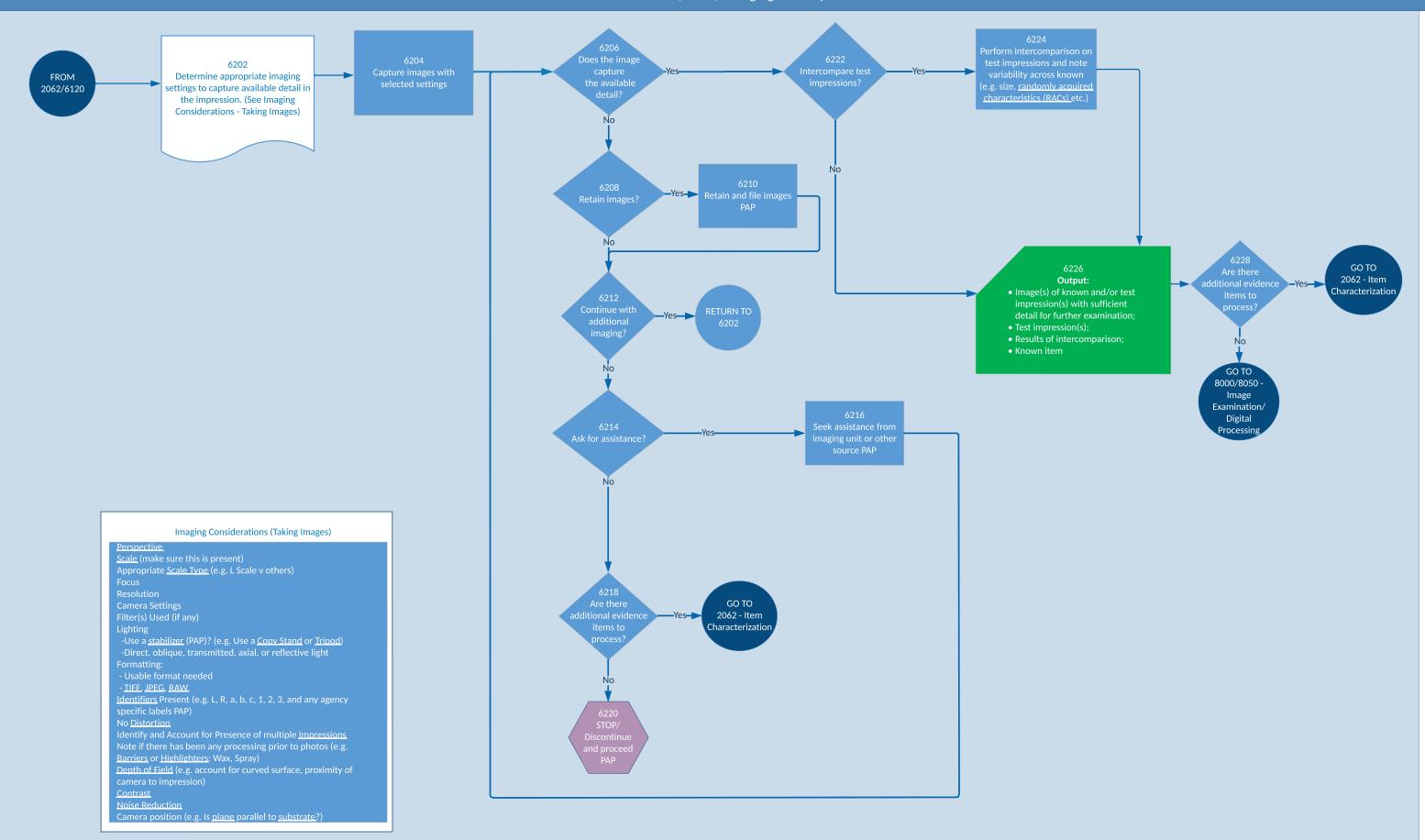
6000 - Known Assessment (1 of 3): Image/Item Assessment



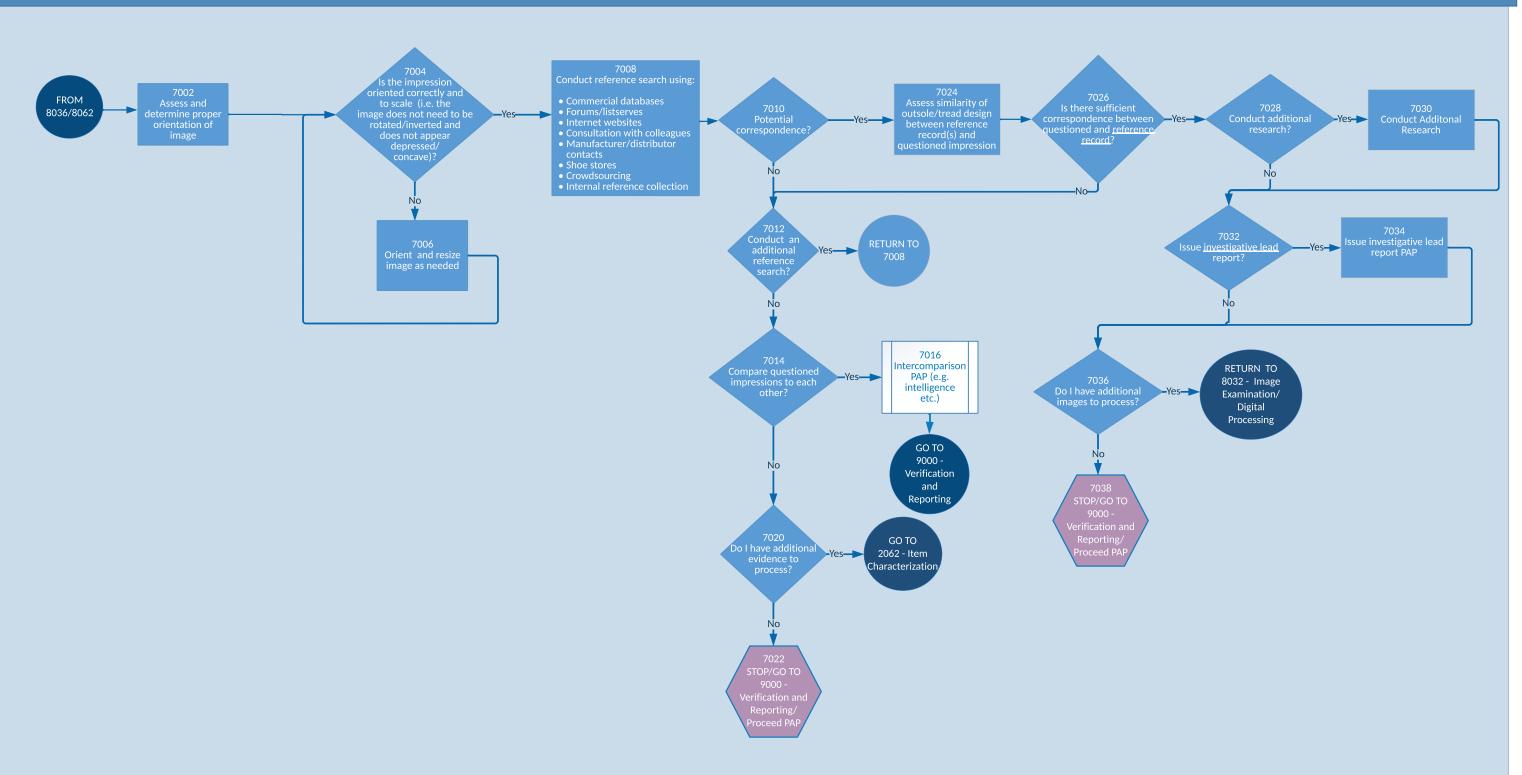
eturn to Overview 6100 - Known Assessment (2 of 3): Test Impressions



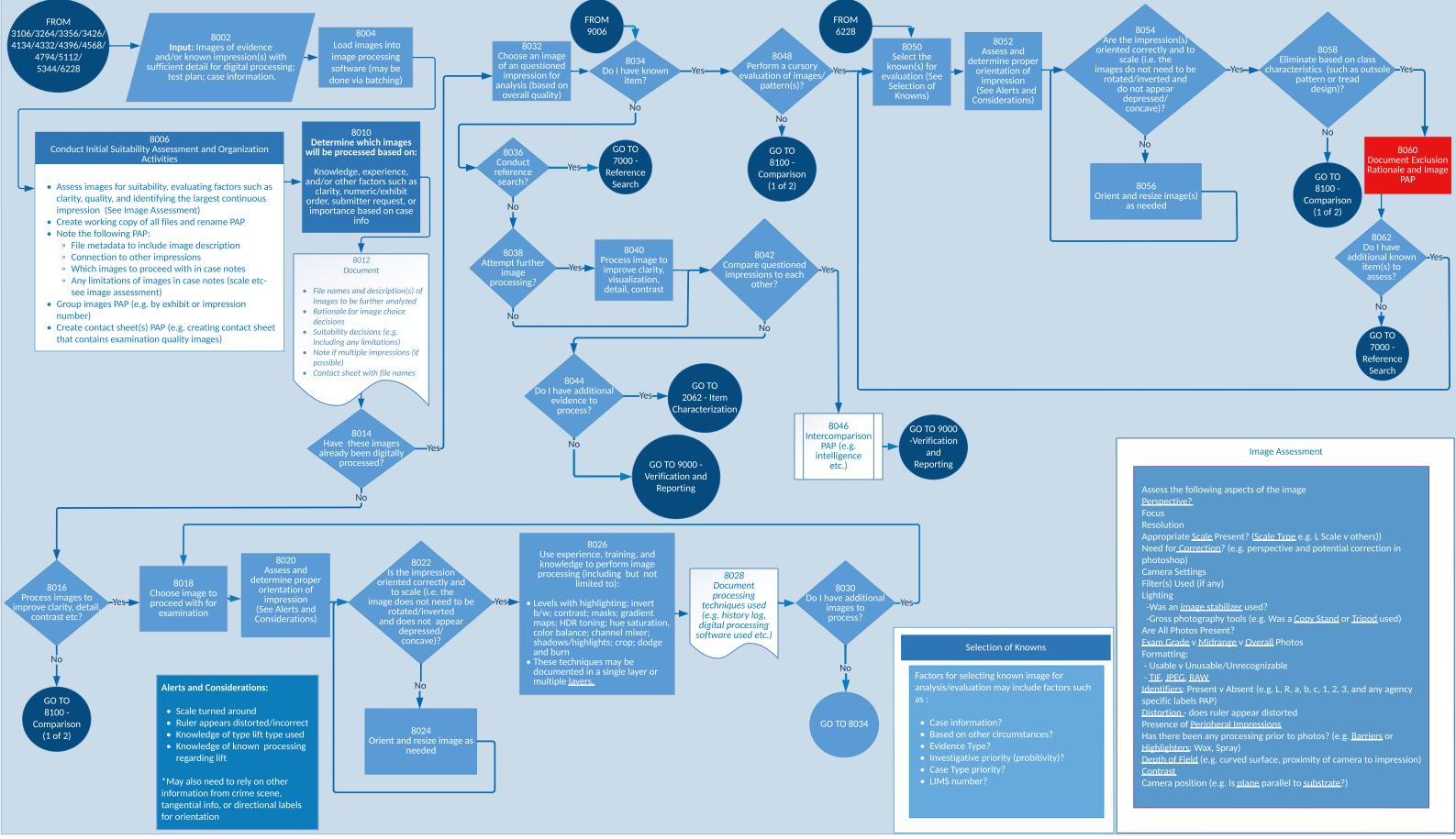
6200 - Known Assessment (3 of 3): Imaging Test Impressions

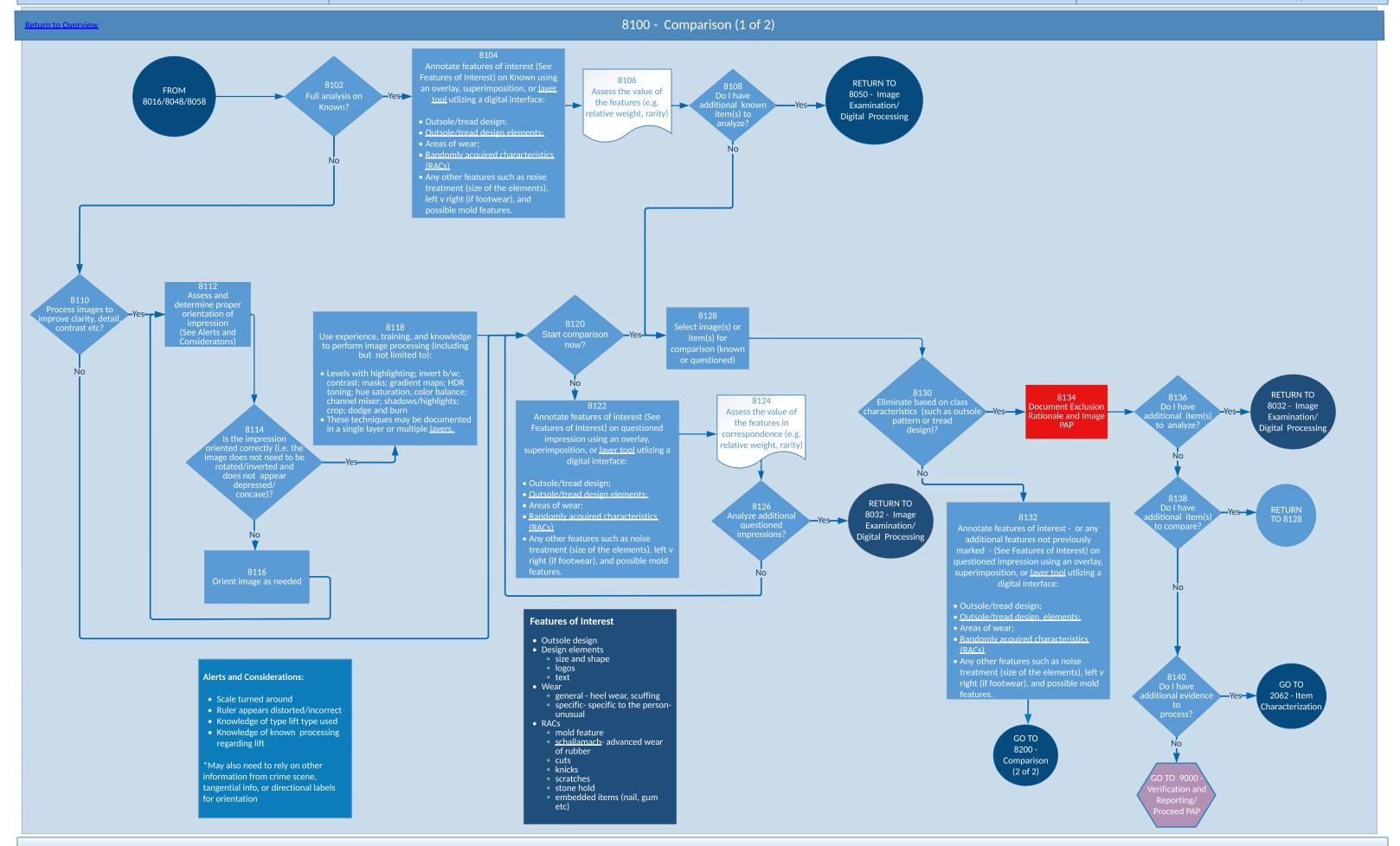


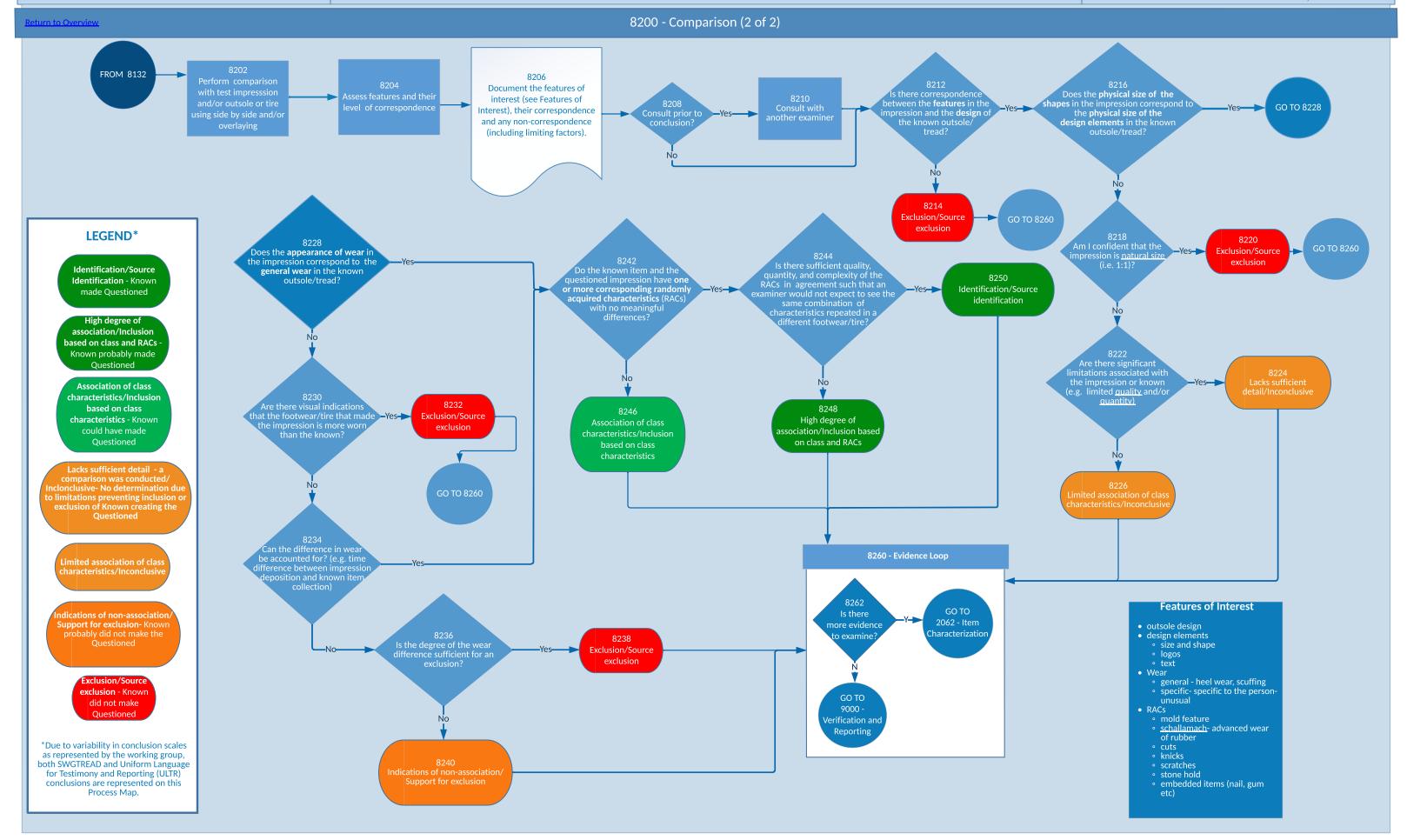




Return to Overview 8000 - Image Examination and Digital Processing

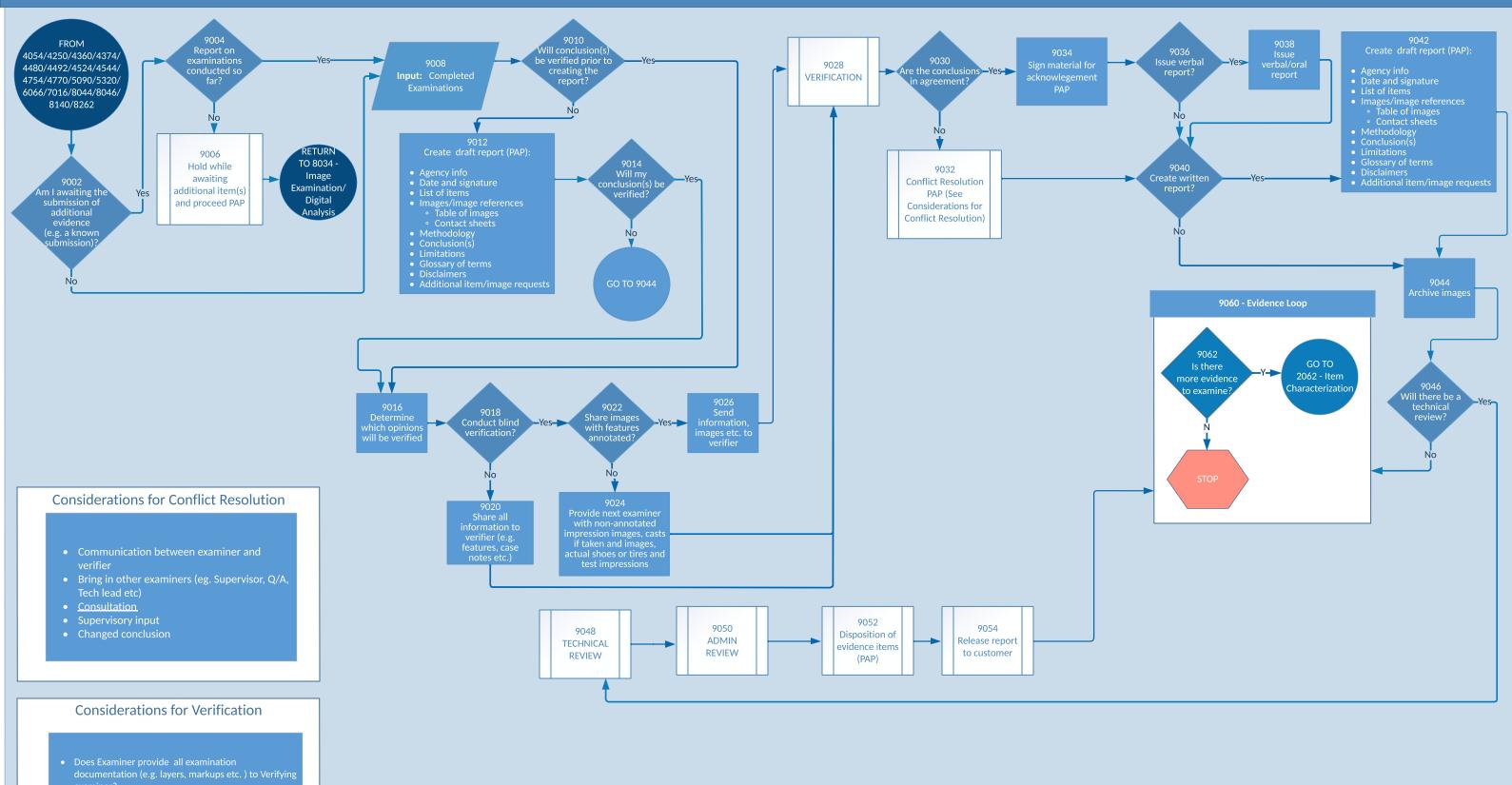






 Does Examiner provide conclusion of comparison to Verifying examiner?
 Will case be completely reworked by another

Return to Overview. 9000 - Verification and Reporting



Glossary of Terms and Definitions

3-D qualities– Three-dimensional characteristics of a footwear or tire track impression.

Background interference– Aberrations in the substrate which the footwear or tire track impressions is present which can cause light or focusing distortions during impression visualization or photography.

Backlighting– Application of light behind a footwear or tire track impression specifically on glass so that the light passes through the impression and into the aperture of the camera.

Barriers– Spray used specifically on footwear or tire track impressions made in soft substrates which hardens on the surface of the impression so that subsequent casting will not damage impression.

Blind search— Conduction a search for footwear or tire-track impressions which are not readily visible to a naked eye by using lighting and or lifting techniques.

Chain of Custody (CoC)– Chronological record of the handling and storage of an item from its point of collection to its final return or disposal.

Chemically or physically processed– Addition of a variety of chemicals or reagents to improve visualization of footwear and tire track impression.

Color contrast– The difference in luminance or color that makes an object distinguishable from other objects within the same field of view.

(Trial) Continuance— The suspension or postponement of a trial or court proceeding.

Contrast– How well black can be distinguished from white at a given resolution.

Copy stand– The stand consists of a platform onto which the item is placed where the camera can be mounted above and parallel to it, usually with an adjustable height. This may or may not include lighting.

Correction– Attempts in image analysis tools to correct or remedy image distortion artifacts.

Depth of Field– The distance that is in focus (sharp) when capturing an image based upon the camera and lens, and their settings.

Distortion– An unclear or inaccurate representation of the footwear or tire in an impression due to interference in the impression-making process or its subsequent retrieval.

Electrostatic Dust Lift– An instrument that utilizes an electrostatic charge as ameans of transferring dry origin impressions from a substrate to a film.

Exam grade(photos)— A photograph taken following a specific protocol for the purpose of conducting a forensic comparative examination.

Gel Lift– Gelatin applied to a pliable backing that can be used to lift impressions

Highlighters– Sprays, paints or waxes used to increase contrast of footwear and tire track impressions particularly in snow.

Identifiers— Details use to establish or recognize the identity of; ascertain as a certain item of evidence.

Impressions– The product of direct physical contact of an item, such as a footwear or tire, resulting in the transfer and retention of characteristics of that item.

Investigative lead– Updated information regarding a case which can assist in the investigation.

JPEG– Image compression and storage format specified by the Joint Photographic Experts Group. It is discrete cosine transform-based.

Laboratory Information Management System (LIMS)– Is a type of software designed to improve lab productivity and efficiency, by keeping track of data associated with samples, experiments, laboratory workflows, and instruments.

Layers– One image is stacked on top of another image and can annotated so that the base image is not affected.

Layer tool– Tool used in image processing software such as Photoshop to apply a layer to an image.

Lighting- Application of light to an item of evidence to observer visually of record photographically.

Limitation— A shortcoming or defect.

Memorandum for record (MFR)– Memo covering information that would otherwise not be recorded in writing.

Glossary of Terms and Definitions

Midrange (photos)– Establishes the location of evidence and what relationship that evidence has to the scene

Natural size— Life-size reproduction. * An image magnification of 1X i.e. the image is the same size as the object.

Noise reduction—*Noise treatment*- The mixed arrangement of tread blocks sizes used by the tire industry to reduce noise generated by tires.

Outsole/tread design elements— A general category of footwear outsole patterns (i.e. herringbone pattern, lugged outsole pattern, wave pattern, plain soles, etc.).

Overall (photos)– Photographs which capture the global aspects of the crime scene to show exactly where the scene was and to show all boundaries of the scene.

Peripheral impressions– Footwear or tire track impression which appear next to the impressions in question.

Perspective– In image analysis, camera-to-subject geometry, including both camera-to-subject distance and orientation of the camera relative to the subject.

Plane– An imaginary line, flat area or field which lies perpendicular to the optical axis. The "Optical Axis" passes through the centre of the lens and the image sensor.

Quality– An inherent or distinguishing characteristic; a property.

Quantity– Physical properties subject to measurement, such as length, time, weight, and concentration. **Randomly Acquired Characteristics (RACs)**– A feature on a footwear outsole or tire tread resulting from random events including, but not limited to: cuts, scratches, tears, holes, stone holds, abrasions and the acquisition of debris. The position, orientation, size and shape of these characteristics contribute to the uniqueness of a footwear outsole or tire tread. Randomly acquired characteristics are essential for an identification of a particular item of footwear or tire as the source of an impression.

RAW– A family of file formats, often specific to different models of digital imagery equipment, that are not yet processed for storage in a 'printable' image format such as JPEG or TIFF. The file extension '.raw' is only one such format.

Reference record— Know footwear or tire track impressions record and stored in a reference library or database.

Scale/Scale type–A ruler marked with a range of calibrated scales (ratios) for drawing and measuring **Schallamach**– Microscopic patterns that develop as ridges on rubber material as a result of repeated abrasive forces. These patterns are very similar in their size and appearance to skin friction ridges and are highly individual. They continue to change rapidly as affected by continued abrasion. Schallamach patterns are randomly acquired characteristics. The term gets its name from a researcher of the same name.

Sidewall –The side of an automotive tire between the tread shoulder and the rim bead which contains information specific to the make, model and manufacturing specific to that tire.

Stabilizer– Devises used to remove movement during image capture which include copy stands and tripods.

Subdesignations– Application of unique identifiers to items of evidence.

Substrate– Surface upon which a footwear or tire track impression is deposited.

TIFF– Tagged Image File Format

Tripod–A three-legged stand for supporting a camera or other apparatus.